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THE CAUSES AND EFFECTS OF GREAT FOREST FIRES.

By John Gifford.

WHEN the early settlers landed on American shores this country, excepting the great western plains and deserts, was covered with an unbroken stretch of beautiful forest, surpassing in variety and value that of any other country in the temperate zone. The advancement and prosperity of the American people depended mainly on this great resource. For more than three centuries it has been recklessly cut and shamefully burnt. Only a remnant of this great inheritance remains.

Epidemics and conflagrations are usually caused by the carelessness or maliciousness of mankind, and both are therefore preventable. It is a blot on our civilization to allow such devastation. Widespread suffering and destruction can only be due to ignorance and callousness on the part of the people. A strong public sentiment needs therefore to be aroused and a remedy will present itself.

For several days recently a cloud of smoke hung over the land and was even blown far over the sea causing a heavy fog along our shores; the sun was dimmed and reddened and the newspapers were filled with descriptions of horrible scenes of death and desolation, due to that prince of enemies, the forest fire. During the latter part of August the American Forestry Association, at the midsummer meeting in the White Mountains, discussed many times the question of fires, and all the while those beautiful valleys were full of smoke from Vermont, where thousands of spruce trees fit for paper pulp were burning.

What we need and what we must finally have in America, is forest regulation. The great work of the forester is to so direct nature as to

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always produce the largest amount of useful forest products on the smallest area possible, with the least expense. It is, in other words, to keep the earth so dotted with evenly distributed woods that the increment will equal all the needs of mankind, while the principal will remain untouched to exert its influence in lessening the destructive forces of nature and in beautifying the earth.

We waste timber. Owing to its abundance at present it enters into the majority of constructions, while architects agree that brick and stone are not only better, but in the end cheaper. The government must do its part in setting aside and carefully caring for large masses of trees in places unfit for agriculture. The farmer must do his part, which is the important part, in growing a few acres of trees on his farm where the soil is poor, not only to furnish him with fuel and lumber but to shield his crops. A small tract of forest may yield many minor products by no means minor in importance to our needy farmers. Pine-knots may be slivered and sold by the bunch in cities at a good price. Even pitch was once extracted from our common pitch pine. Sassafras and cedar yield valuable oils and a still for the process is not expensive. Many low waste places are fit for the growing of basket willows. The black oak and other trees yield tannin and dye. At one time in south Jersey the gathering of sumac leaves for tanning was an important industry. For many years the sumac has been cultivated in Sicily. The woods of many trees are fitted for special uses: the bilsted for market baskets, the persimmon (the only northern representative of the ebony family) for shuttles, white cedar for hollow-ware, maples for sugar, pine slabs for paper, holly for fancy articles, or the chestnut and walnut which need little care and yield handsome returns. From a forestry standpoint underbrush is of value. Let the farmer grow the huckleberry, laurel for rustic work, or many other shrubs which will increase his income, and at the same time preserve forest conditions on a small part of his land. Unity in this respect on the part of the farmers will support many small industries in every locality, and then the forests will become evenly distributed in small well-cared-for patches over all the country. This is the true solution of the forest fire problem.

Our forests at present need simply common sense management. They have had practically no attention except when ready to cut. Trees are allowed to grow like weeds. The largest and best are used first, so that our woods have constantly deteriorated in consequence. The weakest and best must be nurtured, especially while young, else they seldom reach maturity. The writer believes that the absence of trees on our plains is due as much to fire and cattle as to soil and climatic conditions. The first great step is to keep out fire and cattle.

They have done more damage than the woodman's axe. It must be borne in mind that the main difference between a lumberman and a forester is that one uses the axe carelessly, the other with care; the one is endeavoring to fill his pockets with golden shekels just as soon as possible, while the other is content with a smaller and slower but perpetual income.

It is mainly the object of this paper, however, to explain the ultimate effects of forest fire and suggest a means of prevention. It is not necessary for us to dwell upon the enormous loss of life, buildings, timber, etc. We are all familiar with the awful calamities in the northwest, and we can all appreciate the fact that the damage is beyond calculation; but the destruction of standing timber is always insignificant compared with the ultimate effects of fire.

What applies to one section will not of course apply to another, owing to differences in species, in climate, soil, etc. A thorough study of each variety of tree is necessary in order to tell under what conditions it thrives best. Some trees grow better in company with others; certain varieties thrive best in an unmixed forest. Light and shade, rapidity of growth and a variety of conditions must all be considered, and from these data local forestry methods can be devised. Each locality, geographically distinct, must be studied apart from its neighbors. A fire, for instance, is much more easily handled in a level white oak country than in a pine woods on a mountain side. Nowhere, however, to my knowledge, is the consequential damage by fires better illustrated than in the southern part of the State of New Jersey. There for many years, near the largest population centers in America, fires have been raging. They have been burning many times over the same territory, so that the country is impoverished in consequence. Years of legislation and careful reforestation will be necessary before we can again produce such a forest cover as the original.

The region could once boast of large swamps of excellent cedar, forests of pitch-pine and several kinds of oaks. Ship building was once a flourishing industry, and long ago enormous quantities of charcoal were used in the manufacture of iron from a peculiar deposit which was raised out of the bogs. Many cords of firewood are still devoured by glass factories.

The section referred to is about twenty-five hundred square miles in area. It is known as the coastal plain or southern interior. Excepting along the shore, and here and there along the rivers and railroads, it is still an unbroken stretch of scrubby woodland—patches of savanna land and areas of stunted pine, the largest of which is known as the "plains." Here and there are whole forests of the black boles

of trees which have been killed by fire, and occasionally in isolated protected positions are small clumps of beautiful woods characterized by their variety and rapidity of growth. Being the trysting place of the northern and southern floras and favored by a mild climate, a good forest soil, and the proximity to large bodies of water, a great variety of trees can and have flourished there. But the upland is covered with a mangy-looking growth of scrubby trees. Game is scarce, the water supply uncertain, and agriculture neglected. The infernal fires have converted a beautifully wooded region into what is practically a sandy plain. Considering all things it is less prosperous to-day than it was a century ago.

Forest fires are started in four ways: incendiaries, careless individuals, locomotives, and lightning. By far the most serious sources of origin are the criminal dastards who purposely set them, since they select the proper place at the proper time. By means of fire wood-thieves hide their tracks, and many people out of revenge fire an enemy's woods. Years ago charcoal burners set fire to woods in order to buy the charred wood cheaply since it was then fit only for charcoal.

Another serious cause, chargeable to gunners, tramps, and boys in the woods, is carelessness—mainly from the embers of a camp-fire, a lighted match, cigar or cigarette. That locomotives set many fires there can be no doubt. But this can be wholly prevented by the use of the spark arrester, by having places especially prepared for dumping hot coals, and by clearing and ploughing the land for several feet along the road. Careful train-hands are also of course necessary. Often, however, to produce a better draft the arrester is removed or poked with holes, and hot coals are carelessly emptied where they quickly generate a fire. Several fires in south Jersey have been caused by lightning, but this of course only very rarely results in damaging fires because the rains which follow are apt to quench them.

Forest fires burn about six months of the year, and are probably more destructive early in the spring than at other seasons. Many dry leaves have then accumulated on the ground, many still cling to the trees, the wood contains little sap, and the wind has a freer sweep.

A large foreign element has come to south Jersey to clear farms. This much increases the danger from fires owing to the burning of brush and carelessness of workmen. But when cleared these little farms check the headway of a fire. The sooner the forest-cover is distributed in many small patches over the country the better. There will then be no danger from enormous fires, except perhaps in government reservations on large tracts of waste land. Even then, if these be properly regulated and guarded, there can be but little danger.

Fire is very destructive to cranberry bogs and cedar swamps. It is necessary to dig deep trenches in order to check its headway, because it burns deep into the peat and appears here and there in unexpected places several feet away. The bed of a cedar swamp consists of several feet of humus. The bottom is covered with logs, ferns and spongy mosses. The principal moss is sphagnum which is collected and baled for nurserymen. It is used in packing plants for shipment, owing to its ability to hold moisture. Let me emphasize the value of this moss. Although almost indispensable to the florist, its collection ought to be prohibited at least to a certain extent. Noted for its ability to retain moisture, it can undergo an extreme amount of desiccation and still recover. In these swamps streams divide into many streamlets which percolate throughout this mass of material. The foliage of the cedar is so dense that the sun only feebly penetrates. Rain is retained and instead of rushing in a flood to the sea or rapidly evaporating is restrained and gradually distributed. Cedar forests are therefore natural reservoirs of water, effecting a natural irrigation; but the owners of them, for fear of fires, cut the trees in a sappy state when fit only for an inferior grade of shingles and laths, or even hop-poles and rails. An uncertain water-supply is of course the result, since all the rivers of south Jersey rise in swamps and bogs within its own borders.

Young timber is usually killed above ground by fire. Large timber often apparently recovers, but it is always more or less affected. Its vitality is reduced so that insects invade and devour it, and charred wood is always of less value because disagreeable to handle. From the stump of burnt or cut oak many scions spring. These were used for hoop-poles a few years ago, but now, owing to the substitution of bags for barrels and iron for wooden hoops, there is practically no demand. The butts are often gathered, however, for umbrella handles. Some trees can endure more heat than others. The fittest in that respect survive, while other more valuable species perish. The pines are rapidly disappearing, and if fires continue there will be nothing whatever left to hold these sands but low scrub oaks and other brush.

The main reason why oak follows pine is that no second growth comes from a pine stump. When a pine is cut or burnt shoots spring from the collar of the stump, but soon wither and die. Second growth oak is vigorous, although it is claimed that a plant reproduced for any length of time in an asexual manner weakens. Young pines have difficulty in growing in underbrush, but an abandoned field comes up in pine and red cedar. A pine forest is apt to contain an oak here and there, sufficient to seed it, the acorns having been accidentally carried by squirrels or other animals. The effect of fires

on seeds is an important question in determining the growth which follows. Some seeds are quickened by heat, others easily perish. It is certain that some are very easily affected by changes in temperature. Tropical seeds often lose their vitality when carried around Cape Horn. There is an interesting plant known as the fire-weed which comes up in abundance in burnt places. One can often locate the site of an old coal pit by a mass of this plant. It is of course not likely that the seeds have endured the heat, but upon fresh seeding it is the first species able to endure the conditions produced by a fire.

When a swamp-bottom is burnt it often comes up in white cedar, as even and dense as a field of wheat, while a swamp which has been cut and not burnt produces a great variety of trees. Although a common observation this is more or less of accidental occurrence. A swamp bottom is always well seeded with several kinds of trees and shrubs. A fire not only destroys these seeds but forms a soil on the surface. If this occurs when the cedar is in fruit its light winged seeds are quickly sown by the wind. Acorns sink into the soft sand but the light pine seeds remain on the surface and are quickly burnt by a passing fire.

Fires seriously affect sandy soils. They burn all the organic matter on the surface, the ashes are beaten by rains through the porous earth, and nothing is left but hot white sands and charred sticks.

The value of underbrush is underrated. Although it smothers young trees it is indispensable in forests of larger growth. The amount of mineral matter which a tree absorbs from the soil is insignificant. Water is the essential element. In checking evaporation and retarding the flow of water natural litter and undergrowth are necessary. But the smaller amount of dead wood in a forest the better, since it breeds many kinds of insects some of which may invade the living trees. The material resulting from decay however enriches the soil, so it is better to burn all the dead materials which cannot be utilized. In that way the soil is enriched just the same, the insects are disposed of, and the underbrush is not seriously disturbed. It is easy to see, how therefore, fire in a forest is often useful if wholly under control and directed by a forester. Nature with half a chance heals all wounds, and soon after a fire fresh young underbrush springs up from the roots. This tender herbage is relished by deer.

Many animals are killed by fire. Let us wander to-day through the woods of south Jersey and the only sounds are the doleful cries of cheewinks and the cawing of crows. Insects and aquatic animals are apparently not affected. The eggs of birds are cooked in nests and old woodmen tell how turtles, snakes, rabbits and the like are chased together before a raging fire. Many believe that insects increase, owing to the destruction of their enemies. There can be no doubt that flies

and mosquitos are plentiful enough, and during the past season insects injurious to crops have been unusually abundant. Preserve the forest and you preserve the animals dependent upon its fruits. Our game laws are worthless so long as forest fires rage.

It is to be hoped that the general government will set aside many tracts of guarded land. A few acres showing the nature of the country in the wild state will be more appreciated in years to come than at the present time. There the trees may be properly cared for, there remarkable and unusual plants may escape the hands of thoughtless people, greedy botanists included, and there the wild animals may find a refuge and breeding place. But to bring about these changes public interest must be aroused. The people in general must unite and do their part in fostering forest regulation. At present, therefore, it is mainly a matter of education. And just here let us consider the methods and efforts up to date to check the ravages of fire. The owner of the land, if he happens to be near, picks up a few men and hastens to fight it. If the fire has gained headway he is often powerless. If by a change of wind it shifts to another man's property, he draws a freer breath and no longer concerns himself about it. In the heat and smoke men are soon exhausted and often receive little or no recompense. Unskilled persons are picked up, and often the whiskey with which the land owner lures his fighters disables others. Thus more damage than good is done. It requires bravery, skill and an accurate knowledge of the region to stop a fire. By back-firing in improper places fires have often gained in strength. The process of "back-firing" when practiced intelligently is to go some distance ahead of a fire, if possible to a road, and then burn carefully toward the fire. With the aid of sand, the handiest and best material in south Jersey for the purpose, the body of the fire may be diverted and, if not too severe, extinguished. Many will fight fire only at night so that during the day it gains much headway. It is accepted usually as a matter of course, being regarded by the majority of backwoodsmen as a necessary evil.

Roads are excellent points of vantage, and if properly trimmed are generally sufficient to check a fire. One often reads how they jump full half a mile, and how they run at the speed of a galloping horse. If the wind blows sparks are carried long distances. Fires have thus "jumped" our widest rivers. They move at a rapid rate, create a strong draft, and roar like the ocean. In ordinary fires, however, the kind which burn slowly for many days and receive little attention but do much damage, if properly managed at the proper time, a road or a stream or often even a spur of swamp is sufficient to check their headway. It is therefore necessary, first of all, that the overseers keep the brush from the sides of the road. Some progressive wood-

owners have divided their wood-land into compartments and have carefully cut a belt or firebreak around each division. In that way a cedar swamp can be easily protected.

A law has been recently passed in New Jersey providing a fire marshal and deputy in every township of the third and fourth class counties. He has full control of the fires of his district. On a high location, with the aid of a telescope, he can see over almost any township in south Jersey. These stations can be easily connected by telephone, so that information can be sent from place to place without a particle of difficulty. Each marshal is empowered to employ able assistants when necessary. If the law is enforced and every marshal does his duty every fire can be nipped in the bud.

There has been a lack of interest and unity on the part of the owners of wood-land. This has led to the formation of a woodmen's association with the following objects in view:

(1) To improve and protect the forests of the southern counties of New Jersey.

(2) To prevent all wanton and needless destruction of forests.

(3) To insist upon the enforcement of the laws in relation to forests and the punishment of malicious and careless fire-setters.

(4) To adopt such methods of cutting as will increase and prolong the yield of timber and cordwood.

(5) To encourage the planting and seeding of valuable trees on Jersey waste-land, and elsewhere wherever practicable.

(6) And to encourage such methods of forest management as will tend to conserve and increase our water-supply and protect the wild animals of the woods.

It is to be hoped that every state where fires occur will appoint men to act as marshals, and that incendiaries be ferreted out and severely punished. Thus with a more general idea of forestry principles, with associations and periodicals for the dissemination of knowledge on the subject, forest fires can be stopped. Pennsylvania, New York, and especially Maine and New Hampshire, the charm of whose forest-clad mountains means more in dollars and cents than the sum of all other revenues, by much persuasion and argument have been aroused, and the majority of their intelligent people are convinced that trees are indeed worthy of judicious utilization,—that a growth of a hundred years is too precious to burn in as many minutes by a fire from the match of a careless hunter or infernal incendiary. If each state does its share the Forestry Division of the general government will be more than willing to advise and help wherever possible. It is the duty of every citizen to learn the rudiments of forestry, and every boy and girl should be taught to glory in the privilege of an Arbor day.

THE LAND OF THE MIKADO.

By J. Castell Hopkins.

JAPAN is perhaps the most interesting country in the world. After being wrapped in feudalism for centuries and hidden from the nations in a sleep of ignorance and superstition, it was suddenly touched by the electricity of modern progress, and in less than thirty years changed from a condition resembling that of the middle ages in Europe to one which places it on a par with the most advanced nations of to-day.

Little appears to be known of its ancient history. Some six centuries before the Christian era, it was ruled by a great warrior who is said to have been at the head of a Mongol or Chinese invasion and who was the founder of the Mikado dynasty which has held sway in Japan from that time to this. But the regal function gradually lost power and prestige in the Mikado's descendants, being swallowed up to a great degree in the spiritual or religious title. From the beginning of the sixteenth century the Tycoon or secular and military chief of the country assumed almost the whole actual power, the Mikado being a sort of invisible and greatly revered descendant of the gods and their inspired representative on earth. It was at this time that Tayko-Sama rose into fame as the chief warrior and statesman in Japanese annals. He was a man of mean extraction who worked his way up to the practical sovereignty of the country, reduced the authority of the Mikado to a mere shadow, compelled the obedience of the innumerable princes and nobles of the period, and after leading them victorious into Corea, died at the head of an army with which he had intended to invade China.

During the middle of the sixteenth century, Japan was first introduced to the knowledge of Europe by some Portuguese navigators, and not long afterwards, St. Francis Xavier with a number of Jesuits sought out the new and strange land and before long had established a flourishing mission. The whole empire seemed on the verge of conversion; proselytes poured into the fold; and the missionaries soon became so strong as to appear threatening in the eyes of the rulers. The result was a sudden change from toleration to the most intense persecution. Torture and death were the fate of all converts, and in 1860 when Europeans once more entered the country it could be fairly said that Christianity was extinct. For brief and fluctuating intervals after this period the Portuguese, the Dutch and finally the Russians, managed to carry on a little trade and intercourse with the people. But it was

never very important, and the whole nation continued to manifest a most bitter antipathy to foreigners until the expedition of Commodore Perry, U. S. N., in 1852–54; the Earl of Elgin's mission in 1857–59; the resulting treaties and their gradual enforcement, compelled them to conceal the sentiment of hatred which was undoubtedly still felt. The complete and almost inexplicable revolution of 1868 which followed, brought the country at a bound into at least a close resemblance to western government and civilization, changed the system of centuries, abolished institutions which dated from before Nero or Julius Cæsar, and seemed to alter the very disposition and character of the nation.

Up to that time the country was very much like Germany in the days of Luther. The Mikado might be almost termed a Japanese pope; the Tycoon was the secular ruler; the Daimos were the feudal princes; the Saimos constituted the feudal nobility; while the military caste or following which each chief possessed, preyed upon the common people in much the same way as had been done in the sixteenth century by the feudal soldiery of Germany, France and England. But of course, the extraordinary feature is that this condition of affairs should have existed through many centuries in Japan and have lasted up to within a quarter of a century of the present time. The system was not given up however without a struggle; both vindictive and bloody. The principles of modern progress had to encounter a political economy absolutely opposed to external trade of any sort; a religious intolerance founded upon fear of outside influence, and a rampant feudalism which made treaties worthless and national honor not even a name.

Each of the two American treaties cost the reigning Tycoon his life. He felt, it now appears, compelled in each case to sign them although he knew enforcement upon such princes as those of Mito, Satsuma, Kaga and other districts, to be impossible. Death by poison followed and even the Regent, who in 1858 had something to do with the foreigners, was murdered at his palace gates and his head carried to Miako, the Mikado's capital, and there exposed with the inscription: "This is the head of a traitor who has violated the most sacred laws of Japan." But after a period of lawless disregard for treaties, the lives of foreigners, and the rights of foreign flags, Great Britain in 1864 bombarded Kagosima, the principal port, and the other powers joined in several naval displays which finally compelled a sort of unwilling and uncertain respect.

During this very time, however, the volcanic action must have been preparing, which in a few years was to cast off with lightning rapidity the garments of medieval institutions, the power of a ceremonious and superstitious priesthood, the influence of an invisible and infallible head, the authority of sanguinary and uncontrollable chiefs,

the government of crafty and faithless leaders. How it was done is not known to this day. The great revolution does not seem to have had its great leader. No master-mind appears as having directed the masses and controlled the classes. Yet in 1868 a coalition of turbulent nobles and princes united in offering to consolidate the Mikado's power by yielding up to him their feudal and immemorial rights and revenues. A body of men who had instigated or allowed the murder of foreigners and attacks upon British and other consulates, issued a manifesto declaring that their object was "to enable their country to take its place with the other countries of the world." The bitter opponents of external trade and foreign intercourse overthrew the Tycoon and his whole elaborate system of commercial monopoly. The Mikado, after having passed a life of enervating idleness, luxury, debauchery and absolute seclusion, came suddenly to the front, assumed his place as the secular as well as the sacred head of the nation, clothed himself in European garments, went out into the light of day to be seen by all his subjects, and commenced the task of receiving addresses, opening public undertakings, and representing the empire in the eyes of the world, as if he had all his life been a constitutional monarch, grafted upon an eastern despotism.

It was the most marvelous, interesting, and peculiar episode in the political history of the world. There has been nothing to compare with it anywhere. All the ancient landmarks of Japanese policy, statecraft and administration were thrown down as if by one of those volcanic shocks for which the islands are famous. They were replaced within half-a-dozen years by elements of western civilization and government which have elsewhere been the product of centuries of slow and stormy development. Old and new were commingled, and forty millions of people of Asiatic stock dropped almost in a moment from the feudalism of a thousand years into a system of modern monarchical government with a gradual but steady approximation towards the "popular" government of the present moment. It was in the strange realization of the fact that these latter institutions could not be had all in a year that we recognize a quality in the people, equal to that hitherto unrecognizable one in the four thousand nobles of the country who had a short time before voluntarily thrown off their mantles of despotic local power.

The government was formed around the time-honored authority of the Mikado, who solemnly engaged himself to rule in conformity with the will of the people. But no means were given him of ascertaining those wishes until later on, when it was decided that in the year 1890 a parliament of the nation should be called and a representative constitution formed. It was thought that in the interval the

people would be educated up to the ideal. Meantime his majesty was to govern by the advice of a council of state, composed of one prominent man from each of the chief provinces, the prime minister, the vice-premier, and the heads of the several departments of the government. The edicts of this council were to be the law of the land. Development went on thenceforward at almost railway speed. In 1872 a law was proclaimed which provided for the establishment of 53,000 schools or one for every 600 of the inhabitants. A naval college was organized under the instruction of foreign officers; railways were started in several directions; foreigners were everywhere made welcome; strict honesty and honor were shown in all international engagements, and especially in monetary matters. In 1876 an Industrial Exhibition was held and in the succeeding year it was announced that there were 3744 post offices established. In 1884, a new order of hereditary nobility was instituted, the national religion disestablished, the sacred character of the Mikado done away with, all Japan thrown open to foreign trade, and entire freedom of religion granted.

During the next few years, Prince Komatsu, the heir to the throne, visited England and conferred upon the Queen the chief Japanese order of knighthood; Count Ito, the prime minister, introduced a vigorous campaign in favor of western dress and habits; the Bible was translated into Japanese; and a commission went abroad to study the fine arts in Europe and America. Its decision was in favor of Japan: "Pure art is asleep in Japan, but dead in Europe." In 1890, the first free parliament of the empire was opened by the Mikado, or emperor, as he is now styled, in person. It was composed of a house of peers, somewhat after the English model, with ten life members, 139 elected nobles, 59 imperial nominees, and 44 elected men of mark; and a house of representatives having 300 members—all elected. The first president of the upper house and the leading man through the succeeding and inevitable mutations of politics was the Count Ito, already mentioned.

Thus started upon the high road of progressive civilization, the Japanese have come to think themselves the leading power in Asia, the most intelligent people in the world, and have, naturally enough, fallen into the present war, and proposed the abrogation of the international treaties which in latter years have been so unjust and oppressive in view of the entire change of national conditions. One of the best humorous and satirical sketches I have seen of this rapid march of civilization in Japan, and its present effort to sustain an historic policy of acquisition in Corea, is the following from the London *Punch*:

(*From a Record in the Far East.*)

Step One.—The nation takes to learning the English language.

Step Two.—Having learned the English language, the nation begins to read British newspapers.

Step Three.—Having mastered the meaning of the leaders, the nation starts a parliament.

Step Four.—Having got a parliament, the nation establishes school boards, railways, stock brokers, and penny ices.

Step Five.—Having become fairly civilized, the nation takes up art and commerce.

Step Six.—Having realized considerable wealth, the nation purchases any amount of ironclads, heavy ordnance, and ammunition.

Step Seven.—Having the means within reach, the nation indulges in a terrific war.

Step Eight and Last.—Having lost everything, the nation returns with a sigh of relief to old-fashioned barbarism.

But whatever may be the result of this conflict in the East, it cannot involve the complete subjugation of the Japanese. The people are too bright, clever, and powerful in imitation, to be permanently beaten by a slow-going, though mighty mass, such as the Chinese empire. They are wonderfully intelligent. Japanese workmen constructed and worked a steamboat some time before an American or European steamer had appeared on their shores. Long before foreign influence was felt in the land, the libraries of Meako and Yeddo contained as many as 150,000 volumes, and universities were established at both places as well as at Nagasaki. Printing was introduced from China in the thirteenth century, and reading has long been a popular amusement. In the days of feudalism the Japanese knew enough of mathematics to make good maps, and to measure their mountains with a barometer. In the carving of ivory and working of wood they have had few equals. Their skill in making mechanical things, such as toys, tops, etc., is marvelous. Travelers speak of the throwing of tops like a boomerang which return to the thrower, and will spin and continue to spin in all sorts of places and ways for a seemingly interminable period.

Generally speaking the empire of Japan is supposed to consist of three large islands—Niphon, Kin-so and Sikok—but around these are several thousand small ones which have been acquired from time to time. The climate is delightful, the cities numerous and populous, and the chief occupation up to very recent years has been agriculture. The complexion of the Japanese is yellowish, with a brown tinge; the eyes small and not so much sunk in the head as the Chinese; the hair is black, straight and coarse. Their costume is peculiar and voluminous, both sexes wearing very similar clothes. After marriage the women disfigure themselves hopelessly by blacking their teeth and pull-

ing out their eye-brows. Before marriage they are as a rule very graceful in appearance and often exceedingly pretty. So far as the origin of the people can be traced they seem to be the result of a mixture of Chinese and Malays, the former settling amongst the others much as the Normans did in England of old.

It is a land of paradoxes and anomalies. Thirty years ago everything seemed to Sir Rutherford Alcock, the British minister who spent three years of danger in the country, to be in reversed order. The people wrote from top to bottom, from right to left, in perpendicular instead of horizontal lines, while their books began where ours end. Their locks, though imitated from Europe, were all made to lock by turning the key from right to left. The old men flew kites while the children looked on; the carpenter used his plane by drawing it to him; the tailors stitched from them; the horses were mounted from the off side and stood in the stables with their heads where we would place their tails. The ladies blacked their teeth instead of keeping them white, and then as now, the sexes mixed freely in public bath-houses without a thought of immodesty, but piled on clothing when they went into the street. And to-day the natural habits of the people are in constant and amusing contrast with the national and western ideas of the time.

They are, as already stated, wonderfully adept at imitation, and if at all possible will never allow a foreigner to excel in anything. Indeed the only possible explanation of the great revolution is that the nobles saw the superiority of the foreign systems and practices and made a sudden resolve not to let that superiority be felt or known. In the early days of the English legation a lacquer-ware man was given some spurs, curb-chains and stereoscope cases for repair, and finally a lock was given him to fix on a box. He had never seen such things before, but some time after the necessary work had been done it was discovered by the merest accident that many of the articles returned were counterfeits and the lock and key imitations! Cork-screws, glass-shades and other things were easily and quickly copied.

Another curious feature in their character which seems to have largely disappeared under new conditions was the tendency to act as spies and the entire absence of any consideration of dishonor in such a position. Everybody from the Tycoon down was watched and watched some one else in turn. When the Earl of Elgin and Kincardine arrived upon his mission they could not understand who was watching him! No one in his suite seemed to have note-books for that particular purpose and there was certainly no one specially appointed, as would have been the case with them. So, seeing the double name in his signature, the conclusion was come to that the Kincardine who

seemed to be nowhere visible, was in some way "keeping his eye on Elgin."

It would be hard to say just what the present religion of the Japanese is. There are all kinds of sects, Buddhism probably predominating. Since the Mikado renounced his infallible and sacred character considerable looseness in religious thought or superstition prevails—leaving, of course, all the more room for the advance of Christianity. The temples are very simple structures, the chief internal feature in many of them being a looking-glass, supposed to be emblematic of the soul's purity. Near it is a font containing water. In this the worshipper washes, then proceeds to the looking-glass and prays for what he wants, and after leaving a few coppers in a box near by, rings a bell at the door thrice as he goes out.

The wealth and strength of Japan is now very considerable. There are 5,000,000 families who own land in small quantities and farm it to fair advantage. The exports which amounted to $3,600,000 in 1861 were valued at $91,178,000 in 1892, and the imports have risen from $2,240,000 to $75,900,000. The bulk of what the empire buys comes from England, the bulk of what it sells comes to the United States. Its public debt is $267,000,000 and the national credit has been exceedingly good since the country opened its ports to foreigners and sought to rival them in the freedom of its institutions and the advancement of its civilization. It spends nearly nine millions a year on the navy and twelve and a half millions on the army, one million on education and nearly four millions on police. It possesses five armored ships, seven protected cruisers, 12,000 seamen and 245,000 soldiers.

In material affairs the progress of the Mikado's realm has been marvelous. The activity, powers of imitation and natural cleverness of the people, have asserted themselves as clearly in commercial and industrial progress as in political development. In 1872 the first line of railway was opened from Tokio to Yokohama, a distance of 18 miles. In 1893 there were 1864 miles of railway, used during the year by 25,000,000 people. Of these 551 miles were owned, and carefully managed, by the government. The foreign trade of 1892 was double that of 1884, whilst the internal trade in silk-worm eggs and cocoons and in camphor, copper, and similar products, is steadily growing, partly as a result of railways and partly because of the good roads with which the islands are now covered as by a net-work.

In certain lines of cotton-goods the Japanese now compete throughout the far east with British goods, and the excellence of their manufactures is steadily increasing. Still, 82 per cent. of their foreign trade is in foreign hands and controlled under treaties made twenty years

ago and entirely out of harmony with existing conditions. In 1892 the country exported five millions worth of gold and fifteen millions of silver; possessed 1,546,000 horses and 1,044,000 cattle; produced 90,000,000 bushels of rye, wheat and rice, and grew 55,000,000 pounds of tea.

Business methods and institutions in the England of the east are very similar to those upon this continent. In 1878 the first chamber of commerce was started. Now there are fifty of them, together with 2013 trades unions; 13 rice exchanges; three stock exchanges; three general exchanges, and 134 national banks. The Bank of Japan is a well-managed and stable institution with large capital. Then there are 2631 joint-stock companies and 2489 factories of which one-third are run by steam-power. Of the 767 serial publications, 167 are devoted to agriculture and about the same number to science. Besides the universities elsewhere referred to, there are five government technical schools equal to the best in European countries. It is little wonder, in view of such a twenty year record, that China is having the worst of the contest with her vigorous and clever antagonist!

The empire may therefore be said to have fairly established itself and the people to have earned the reputation of being the most remarkable nation in Asia. What may be ahead of them in the way of development or misfortune no one can predict, but whatever it is they have given to Asia a beacon-light of civilization from which much should be learned. Within twenty-five years they have achieved what European peoples have taken centuries to do. The monarch has thrown away his imperial robe of seclusion and the halo of religious veneration which were his by right of 2000 years of precedent and power. The feudal system and oppressive oligarchy have been swept away in favor of a free government and a foreign scheme of rule. The once hated foreigners are given ample freedom, welcome, and even employment. Where the shores once bristled with dangers to navigation, light-houses are now everywhere established. In the capital where the British minister twice nearly lost his life, twelve foreign powers are now represented. Where the highway of Yeddo once threatened him with death, the foreigner now rides his bicycle, with the whistle of the locomotive in the distance, and the sound of the telegraph operator at given intervals.

Well, therefore, have the Japanese earned the right to call themselves a progressive people and to speak of "new Japan; the land of the Rising Sun." And whether right or wrong in the present war; whether finally victorious or defeated, we cannot but hope that they may remain a light in the eastern sky until the day of a final and better dispensation dawns upon the nations of Asia.

THE USE OF TERRA-COTTA IN MODERN BUILDINGS.

By George M. R. Twose.

EVERY reader of the periodical literature of the day, especially the technical journals, is familiar with the individual who occasionally appears in the correspondence column with a brand-new answer to his own conundrum, "What is the age in which we live?" This individual, anxious lest the period should pass unchristened into the irretrievable past, is fond of informing us that the world has at various times been distinguished by an Age of Stone, an Age of Iron, and an Age of Bronze, and he frantically urges his generation to devise some title by which these days also may be identified in future eras. The gentleman in question is generally supposed to be brother to that other intelligent person who fiercely demands of architects "Why don't you invent a new style?"

We have dug up past and forgotten ages from oblivion and laid them, carefully cleaned and labeled, on the museum shelf. That task was comparatively simple as compared to the one awaiting those who are to dig us up, restore and ticket our frame houses, apartment-houses, and office-buildings, trace the germ through its development, and probably haggle over the precise number of æons that must have elapsed ere the primitive wooden structure bloomed and blossomed into the stately steel-ribbed "sky-scraper." The mound-builders were faithful to the simple traditions of that system of construction long enough for it to become nationally characteristic; the cliff-dwellers displayed no new and wanton fancies in successive decades with regard to the appearance of their dwellings, but the sons lived as did the fathers, and left no complicated question of architectural development for us to unravel, though it must be admitted they provided abundant food for surmise in other directions. So, too, we know the ancient Egyptian through his pyramids. But by what will Macaulay's New Zealander know us?

In the architecture of the present day no single material has remained the medium of expression for a length of time sufficient for the development of any individuality founded on the character of its builders, local circumstances, or popular ideas; and the architectural history of every spot—Chicago for instance—is a record of continuous change. The frame house endured for a generation and was succeeded by the edifice of red brick, which in turn succumbed to the

superior attractions of the "Early '76" style of brown stone and galvanized iron. This was the herald of a medley of various-hued stones; and color having become an attraction, bricks reappear in a rivalry of motleyness; fascinating color combinations begin to absorb the attention of the architect; and then the restless energy of the day pushes into his hand a new material bidding him reject all others in its favor.

Terra-cotta as a building material is essentially a product of the

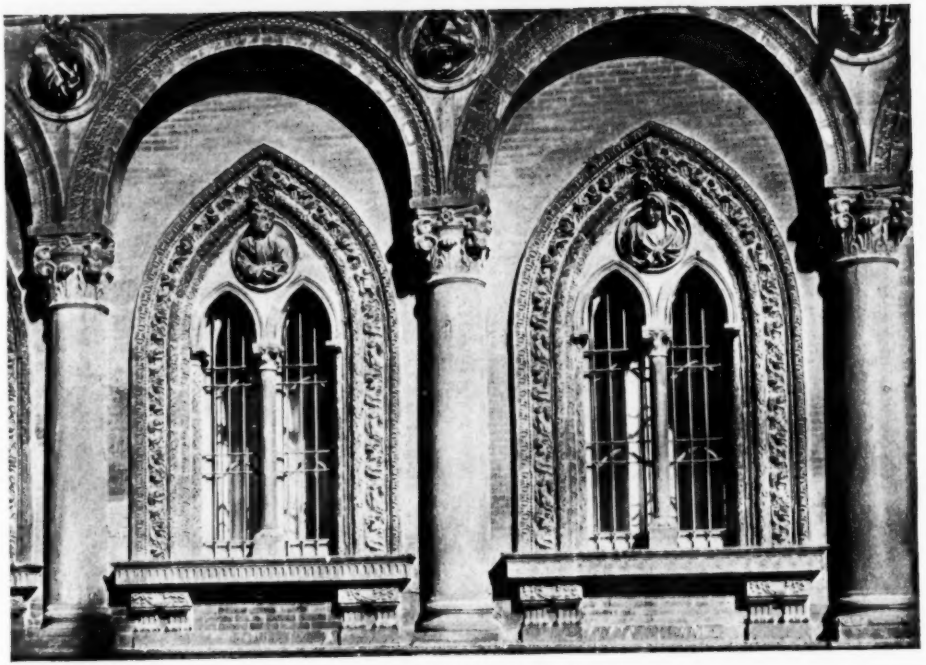
THE ASSUMPTION, AT THE CEPPO HOSPITAL, PISTORIA.
BY GIOVANNI DELLA ROBBIA.

age. Though its use primarily was the outcome of certain requisite conditions encountered in the erection of office-buildings, it quickly graduated from merely utilitarian duties, and is no longer confined to the construction of floor arches and the enclosing of beams. It appears in the fronts of buildings with its inherent beauties well developed, challenging attention as much for its esthetic qualities as for those more solid merits which make it one of the most valuable

ARMS OF THE UNIVERSITY COUNCIL OF MERCHANTS, AT OR SAN MICHELE, FLORENCE.
BY LUCCA DELLA ROBBIA.

CREST OF LORENZO DI MEDICI IN THE MUSEO INDUSTRIALE, ROME.
BY LUCCA DELLA ROBBIA THE YOUNGER.

TERRA COTTA MEDALLION, SAN MICHELE.
BY LUCCA DELLA ROBBIA.

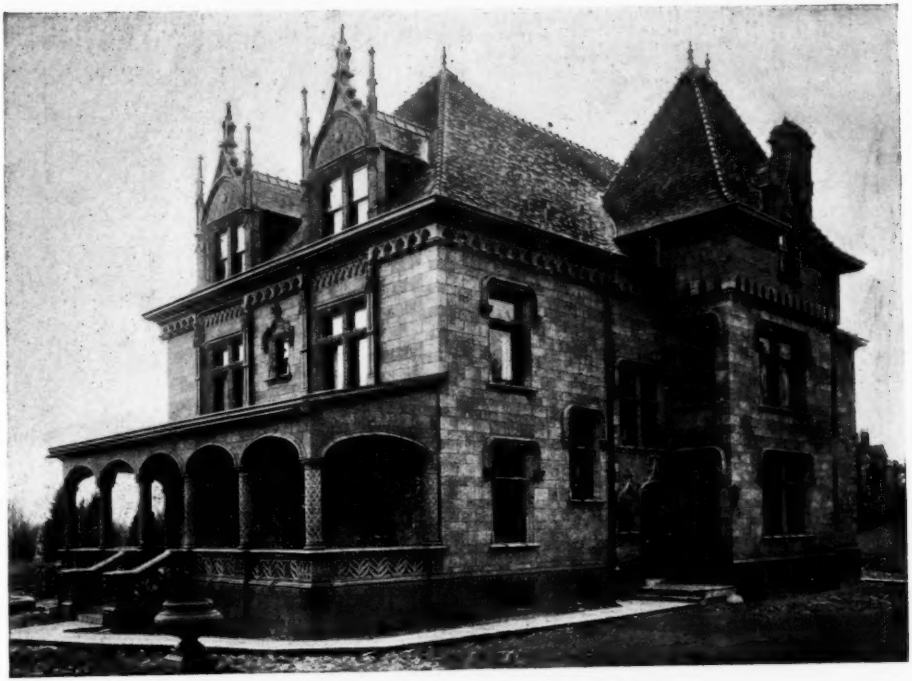


THE GREATER HOSPITAL, MILAN.

of building materials. It is, as far as its uses are concerned, a new material, the intelligent treatment of which may lead to new architectural forms, generally the result of new material and new ideas for which the critic clamors.

In any consideration of terra cotta, however, we must be careful to distinguish between the two different positions in which it is found. The conditions are so dissimilar, and the duties exacted of the material so different, that only a plastic substance like terra-cotta could adapt itself to such varied circumstances. In its ordinary architectural use, as in string-courses, sills, copings, panels, or as the entire walling, terra-cotta occupies an entirely different position and performs work entirely different from that demanded of it when, in conjunction with steel, it helps to rear a modern office-building. It is then the substitute for the heavy masses of brick-work which a few years ago were the exterior fireproofing material. Certain advantages which it possesses over brick-work (in addition to superior fireproof qualities), such as great comparative lightness, adaptability to every position and form, great responsiveness to artistic thought, and the possibility of its manufacture in blocks convenient for handling and setting with great speed, make terra-cotta the material *par excellence* for use in this connection. In its possession of necessary strength with a minimum of weight, ability to conform strictly to the structural necessities of another material, richness of color and great capability for magnificence of effect, terra-cotta is an almost perfect symbol of the convenience and luxury on an economic basis which distinguish the great buildings in which it is thus used.

When first experimentally introduced terra-cotta was regarded very largely as an imitation stone, a material with which it was possible to include in design the decorated surface, the cusp, the quirk, the crocket, and the finial, hitherto forbidden by the great cost of such work in stone. In the desire to make the utmost use of this plastic quality, which is at the same time the great strength and the great weakness of terra-cotta, the greater possibilities of an individual development were overlooked. All discrimination of material was lost sight of in the eagerness with which architects applied themselves to producing with its aid erections, which, lacking in due recognition of material, can only be classed as elaborate pieces of mimic masonry. Used as a component in legitimate masonry construction, terra-cotta suffers very largely even to-day from this misunderstanding of its nature, and this is most clearly demonstrated by the fact that nearly every building in which it has been used exclusively would look a good deal better if executed in stone. The inferential conclusion is that the designer of each such building must have thought in stone and de-



A TERRA-COTTA RESIDENCE IN IMITATION OF STONE.

"Every building in which terra-cotta has been used exclusively would look better if executed in stone."

signed in stone, and that terra-cotta possessed for him no individuality sufficiently strong to compel a recognition and impress the result with its characteristics. We have yet to appreciate the distinction between terra-cotta as a material *sui generis* and terra-cotta as an imitation stone.

Architectural problems hitherto have been solved by means of stone, or brick, or wood, and in so far as the design was properly related to the material and the idea to be expressed, so far was the result a successful one; and the greater of these results are the standards of to-day. Omitting the strong tendency to centralization which has created certain new problems that have been successfully met by the use of steel, the demands made by present civilization upon architectural construction are substantially those which have been made during past ages; but we have in terra-cotta a new material with which to solve them. The question as to how far that material has an individuality of its own, and how far it should assume the characteristics of another, is an interesting one.

Used in blocks similar to ordinary stone-ashlar, terra-cotta produces a wall whose strength, like that of a stone or brick wall, lies in the combination of the units composing it. But as brick architecture is essentially different from stone architecture, on account of the different natures of their component units, so work in terra-cotta may be expected to develop an individuality of its own in so far as the peculiarities of its composition and manufacture distinguish it from other building materials. While having the strength of brick-work, the different nature and size of the terra-cotta blocks demand a different disposition from that which we have learned to be the best for bricks. Again, a modification of certain constructive portions is the immediate natural outcome of the dissimilarity existing between terra-cotta and stone; in spanning openings, for instance, when terra-cotta trabeation is forbidden by the tensile strength of the material, a similar construction to the straight arch in brick-work being the alternative; or in arches when the hollow terra-cotta blocks used constructively require a greater length of voussoir than does the solid cube used by the mason.

Examples of the differentiation of the form of a weaker material used constructively may be found in the work of the late H. H. Richardson. In many cases the field of the wall is of granite while the arches (almost exaggerated in size) are of sandstone, the lower crushing resistance of the latter material furnishing the reason for the great size of the arches as compared with the granite forms. The dimensions of voussoir and other stone constructive forms are generally so much in excess of the size which mathematics requires that terra-cotta arches may often be of the same dimensions as those of granite

in similar positions, and still be violating no law, the pleasing of the eye more than the observance of strict scientific construction dictating the result Yet it is evident that a fundamental demand for difference of treatment exists in the very composition of terra-cotta, and reasons multiply as we proceed.

TERRA-COTTA OR STONE —WHICH ?

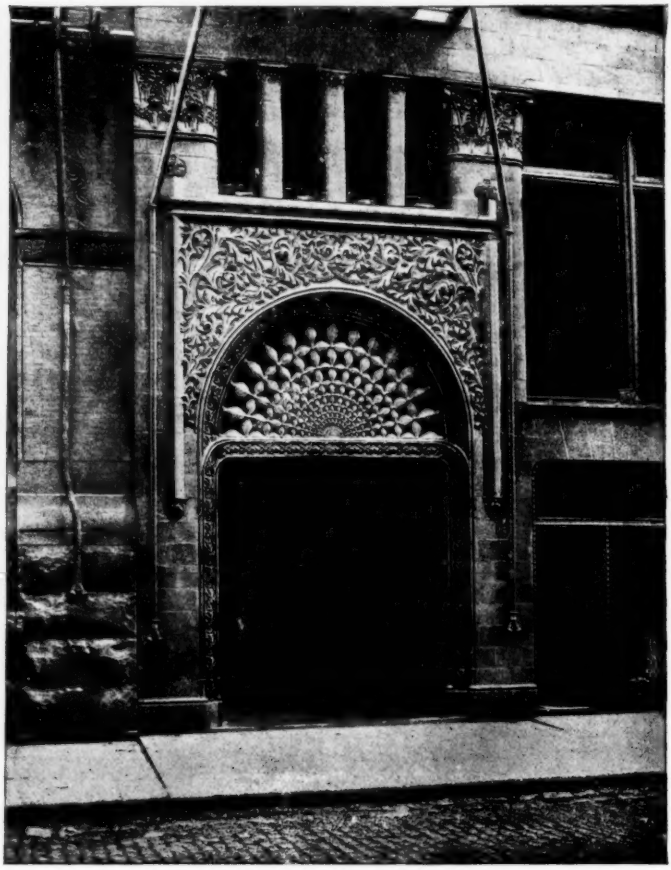
"The question as to how far terra-cotta has an individuality of its own and how far it should assume the characteristics of another material is an interesting one."

Since the economy of manufacture limits the size of the product, very large or heavy projections of single pieces in cornices and similar features are out of place in strict terra cotta work, inasmuch as they require concealed supports, and present difficulties which prevent one from regarding buildings in which such forms are incorporated as successful unions of design and material.

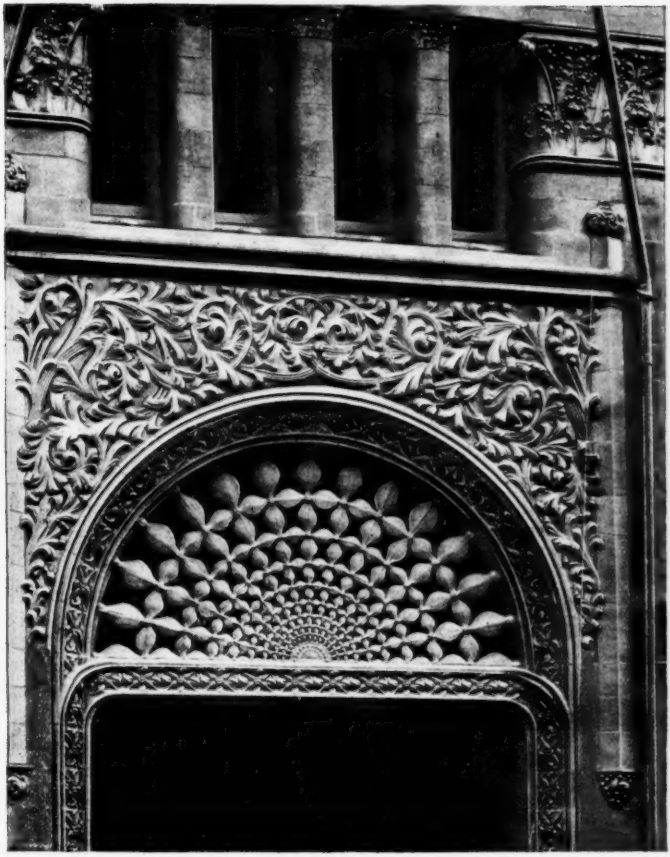
The Renaissance palaces designed by Michael Angelo and Bramante depend for much of their effect upon the magnificent cornices which crown them. These cornices are of stone, and have the great projection which the chemical conditions of the material render easy and legitimate. With the spread of this particular style of building to districts where clay is more easily procurable than stone, we do not find any attempt to reproduce in any imitative way the stone form or its projection; and yet many of the Italian towns afford examples of brick cornices which cap their building with an esthetic value equal in richness and effective-

A VASE, INDICATING THE POSSIBILITIES IN MODELLING TERRA-COTTA.

ness of light and shade to any of the stone prototypes. This was accomplished by an intelligent recognition of the limitation of brick-work and terra-cotta. By obtaining in height what was impossible in projection, by an additional richness of detail and surface and a skillful use of forms properly attainable by a combination of small units, a cornice of brick-work was created which, while similar in its effect, giving the same impression, performing the same duty, and occupying both structurally and artistically the same position as that of the



ENTRANCE, RAND-M'NALLY BUILDING, CHICAGO.



"It is in its more decorative aspect that terra-cotta becomes *facile princeps* among building materials."

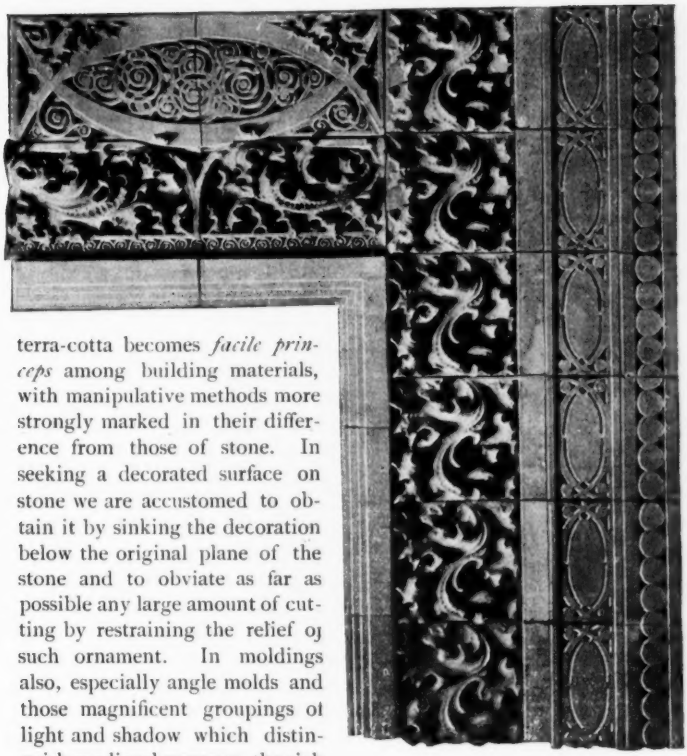
stone example, was yet entirely different in composition and construction, and the manner in which the effects were obtained. This difference of treatment was merely the result of a proper appreciation of the difference existing between the two materials.

Terra-cotta occupying a medium position in point of weight, manufactured size, and color, between stone and brick, we are not likely to find in its proper use such a great distinction as exists between brick-work and masonry; for, while possessing qualities which are

peculiar to itself, it at the same time partakes largely of the character of both. Omitting all consideration of what may result in the way of modeled and decorated forms from a development of its plastic qualities, the difference between terra-cotta and stone or brick would seem at present to lie in the elimination of those forms of both which are not attainable in this material,—a distinction of omission rather than one of commission.

The transom-bars, for instance, of which French domestic architecture of the fourteenth and fifteenth centuries afforded so many examples, owed the possibility of their existence to the fact that stone was obtainable in pieces of sufficient length to span the window openings, and was of sufficient density to permit its use in this respect in pieces of small section. These two qualities are not ordinarily obtained in terra-cotta, so that a copy of these transom-bars in terra-cotta is produced (as witnessed by three examples in the locality of the writer) by the employment of several pieces where, in the model, only one was used, the consequent straight joints occurring in unsupported lengths offending the eye and the sense of stability. The inference would seem to be that terra-cotta transom-bars, unless constructed in such a manner as to give a satisfactory esthetic impression, had better be omitted, and that their charm in stone architecture is not an excuse for mimicking them in another material whose aptitude for such an operation falls short of the ability to produce even a satisfactory imitation. The buttress and pinnacle, again, if used in their proper constructive spirit as members whose value to the organism of which they are a part consists of the sheer weight they oppose to certain thrusts, are forms which are beyond the range of terra-cotta construction, although well within those of brick; a fact easily accounted for by a comparison of the average weight of a terra-cotta block and the weight of brick-work occupying a similar space. Yet terra-cotta buttresses and pinnacles are not unknown. These are but two examples of the thoughtless copying of the picturesque forms peculiar to stone that marks the present use of terra-cotta. Too many others could be enumerated if it were necessary.

No definite line of demarcation can be drawn between terra-cotta and stone so far as general forms are concerned, any more than between brick and stone: but the causes for omission and demands for a difference of commission which have been quoted can be multiplied to an extent which show the necessity for discrimination in dealing with terra-cotta and its right to be regarded as a distinctive material. This difference does not end with any variation of constructive laws, however, but continues through all the phases by which terra-cotta is known to the building world. It is in its more decorative aspect that

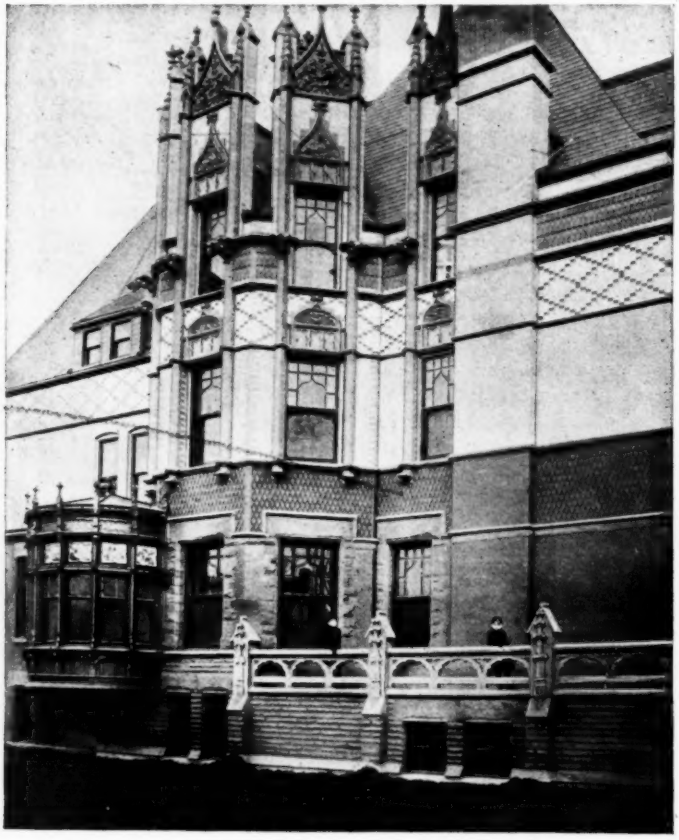


"The varieties of decorated surface."

terra-cotta becomes *facile princeps* among building materials, with manipulative methods more strongly marked in their difference from those of stone. In seeking a decorated surface on stone we are accustomed to obtain it by sinking the decoration below the original plane of the stone and to obviate as far as possible any large amount of cutting by restraining the relief of such ornament. In moldings also, especially angle molds and those magnificent groupings of light and shadow which distinguish medieval masonry, the rich effects are obtained by cutting back the hollows from the original plane. The worker in terra-cotta, however, is not confined to any one such method, since he is not confronted with a rectangular cube of stern uncompromising material but a plastic mass, easily manipulated and modeled and assuming with equal readiness any form that the mind may suggest. Relief, therefore, is not so limited, and that system of decoration known as "cameo" is as easily rendered by terra-cotta as the "intaglio" one to which stone is somewhat confined.

The massive effects of large and rock-faced stones with their appearance of vigorous crystalization are to a certain degree unattainable in terra-cotta, on account of its limitations of texture and size. Yet this is compensated for by the ease with which it is ornamented, and

surface patterns of large and bold design, with deep interspaces and shadows, may be considered as the parallel in this more decorative material of the quarry faces of nature. At the other end of the scale, polish is duplicated by glaze, while between lie all the varieties of decorated surface attainable in terra-cotta with an ease which is paralleled in no other building material. Repeated ornament is especially easy to obtain, and though repetition of molded ornament is not a thing for vigorous commendation, there are occasions when it is effective as well as economical, in the emphasis of function for instance,



A SOUTH SIDE CHICAGO RESIDENCE—TERRA-COTTA DECORATIONS.

and we may yet see the day when the separate modeling of each piece will permit a certain difference and freedom in each repetition.

The ashlar form of terra-cotta, like the brick-work of the day, is beginning to suffer from too high a pitch of mechanical perfection, and this is very apparent where plain walling is concerned. The Cinquecento buildings of terra-cotta possess, as a rule, wall surfaces of beautiful variety of tone, arising from the different shades in the blocks and an absence of any attempt at the mechanical symmetry of color which the brick-maker and terra-cotta manufacturers of the day have set as their ideal; the homogeneity of tone they aim at may testify to their great control over their method of manufacture, but it is done at the expense of picturesque variety and charm. In a final comparison terra-cotta possesses one great advantage over stone for its use in cities, and that is a surface which, after its baptism of fire, is capable of successfully resisting the strongest gases and acids that the foulest city air contains, and one which every shower of rain restores to its pristine freshness, washing off the tender overtones which smoke and soot so delicately spread.

It will be seen from this brief comparison that terra-cotta possesses several distinctive properties which call for their own treatment and place it in a different class and under different regulations from those guiding the use of stone. Although the fundamental architectural forms are little capable of change, the difference in broad general treatment which the material demands will, if we faithfully adapt our design to its idiosyncrasies, give to terra-cotta an architecture as distinctive in character as that based upon wood or brick or stone. It is in a consideration of the ethical character of terra-cotta that one encounters the greatest objections that are to be urged against its use, and, paradoxically, its greatest virtues are its greatest vices. In all history we find that those peoples who have had to struggle with physical conditions and earn their harvest at the expense of hard labor, have become nationally more noble and dignified, and possessed of greater activity and courage, than have those peoples who dwelt in lands where nature gave almost without the asking, destroying in her prodigality all motive of initiative and action. It is the labor they demand, and the skill that has to be employed before they record the thought of the artist, that give to stone and marble the nobility and dignity they possess in architecture. Terra-cotta, however, opposes no such barrier before yielding, but, being plastic to a degree, may be said to leap forward to the modeler and, meeting him almost half-way, realizes at once the grandest and broadest conceptions with an ease equalled in no other material.

Unless the nature actuating it be one of dignity and great restraint, capable of severity and self-denial, terra-cotta in its easily-attained

"The use of terra-cotta is already spreading to domestic construction."

prettiness and its temptation to overload with ornament and indulge in sensuous display, may be regarded almost as an immoral material, and one whose unrestrained use is likely to militate in the worst way against the high and pure laws of true architecture. The very ease with which it realizes the modeler's thought, which is one of its best qualities (admitting as it does of variation and improvement in the work as he proceeds), is also a quality which tends not only to a large amount of poor and overdone work but also to a standard of work which is unrestrained by the severity which stone to a certain degree imposes on design; a class of work with a prettiness that is frivolous, and lacking in fiber. This is a danger that is imminent, for already the use of terra-cotta is spreading to domestic construction, and in one or two instances noted, is remarkable for an efflorescence of ornament which would do much to discredit any material.

The question of color in terra-cotta is far too large for treatment here, and is important enough for a separate series of papers. It is a matter, however, that does not affect this slight consideration as to how far the constructive uses of terra-cotta are parallel to those of stone. The result of our examination would seem to point to the existence of as strong a case for the recognition of terra-cotta as a material governed by its own peculiar laws, as that on which the individuality of brick architecture is based.

In our consideration of terra-cotta the supposition has been followed that the terra-cotta block has been used constructively as is the individual brick, recent domestic work in terra-cotta warranting one in doing so. The pleasing practice of hanging the blocks with wire to a steel beam is evidently removed far beyond the jurisdiction of the ordinary constructive laws of the pendant material, and for this and other obvious reasons does not enter into the scope of this consideration. What seems to us the redundancy and extravagance of much of the Italian renaissance terra-cotta is also passed over, from the fact that this being the expression of southern natures, any one rashly entering on such a discussion involves not only himself with the great subject of latitude in art, but the greater one of latitudes also.

Differences of opinion exist on most questions, but it would seem as if all might unite on the statement that most modern designers in terra-cotta, consciously or unconsciously, think of their designs in stone, and that such a method not only is opposed to art canons but is unwarranted by the individual character of the material itself.

PRESENT STATUS OF THE NICKEL INDUSTRY.

By W. L. Austin, Ph. D.

ALTHOUGH within the past five or six years the consumption of nickel has very largely increased, still the actual amount of this metal used in the arts and manufactures is insignificant when compared with the quantities of other metals consumed. Statistics published in 1889 show that the total weight of nickel produced in the world at that time did not exceed from one-half to one-third that of the silver and only equalled from 1-150 to 1-250 that of the copper. This is the more strange when the valuable physical and chemical properties of nickel are considered, for although once classified among the precious metals, it is not at all a rare metal. With a specific gravity (8.80) very little in excess of that of iron (7.86), it possesses several advantages over the latter metal, among which may be mentioned greater strength when subjected to a breaking strain, and practically non-corrodibility under ordinary conditions, retaining its brightness and polish even when exposed to the action of vapors and gases which readily attack most of the common metals, silver included. Another valuable quality possessed by nickel is that it can be welded to iron and the two metals then rolled out into thin sheets, which for many purposes are as good as the more costly solid metal. These and other well-known characteristics of nickel may be observed in articles of everyday use, and have led to its employment for plating purposes, culinary utensils, minor coins, chemical apparatus, door-plates, oil-cans, harness-ware, etc.

But the use of solid metallic nickel is still very restricted, owing largely to its cost (50 cents per pound), which in turn is due to the complicated and extravagant methods employed in reducing it from its ores. That there is ample room for improvement in the metallurgical treatment of nickel ores is borne out by the fact that in Norway the cost of mining the ore is only one-seventh part of the selling price of the finished metal. It is not a difficult metal to treat, nor is it as hard to work up as might be inferred from statements current with regard to its infusibility. Cube nickel melts well in graphite crucibles in a good coke fire* and at the Chicago World's Fair among a variety of interesting nickel products the Canadian Copper Company exhibited a block of practically pure nickel weighing 4500 pounds.

* Wedding in Jahresbericht. Chem. Tech. 1893, p. 281.

The principal trouble experienced in the metallurgical treatment of nickel is in its separation from other elements with which it is found associated in nature, or which are taken up by it while undergoing the various processes to which it is subjected. Even in the case of very pure ores, such as those of New Caledonia, the sulphur, and to some extent the carbon of the fuel, combine with the nickel during treatment, thereby producing an impure metal and complicating subsequent operations.

Whatever new uses the future may have in store for nickel, at the present time it finds its most extended application in the form of alloys with other metals such as copper, zinc, iron, etc. Some of these alloys have for a century or more been known in the trades under a number of fantastic names such as German silver, maillechort, argentan, pack fong, tutenag, etc. ; but the most important of all, the one from which the human race is apparently to derive the greatest benefit, is the alloy with iron, known as nickel-steel, and which has been brought into more or less prominence of late years in connection with experiments on armor and ordnance material instituted by the United States Navy Department.

This alloy furnishes us with another confirmation of the old adage that "there is nothing new under the sun," for in nickel-steel we find the great powers of the earth at the end of the nineteenth century reverting in their armaments to the use of a material similar to that to which primitive man had recourse. Meteoric iron is perfectly malleable and may be easily forged into cutting instruments, and it is well known that such articles have been made by savage and semi-savage nations from this material. Therefore in all probability the first iron employed by man was of celestial origin—all meteorites contain nickel —and where available he utilized it in fashioning his instruments of offense and defense. Now, after the lapse of many centuries, nickel is again assuming an important rôle in the preparation of war material, for the bullets of modern military rifles are cased in a nickel alloy, and iron alloyed with nickel is largely used in the manufacture of modern guns and protective armor.

Nickel, although not as predominant as many other metals, is very widely distributed over the earth's surface, more so than is generally supposed to be the case. Outside of the few well-known important deposits mentioned below, there are others existing which are considsidered of lesser importance at present, to which many more would undoubtedly be added, were any considerable demand for the metal to arise ; for nickel in its mineralized form is not easily recognized even by those whose calling familiarizes them with ores, and therefore often escapes notice.

The two most important deposits of nickel ore at present known to exist are found on the island of New Caledonia and in the Province of Ontario, Canada. Large deposits of less importance occur in Norway, Sweden, northern Italy, Germany, Austria and Russia, while ore bodies more or less extensive exist in the Provinces of Quebec, British Columbia, and New Brunswick in Canada, also in Spain, Greece, Tasmania, New South Wales, India, Great Britain, South America and in Baja California, Mexico. In the United States important deposits are found in Oregon and Nevada, while nickel is known to exist in the states of Arkansas, California, Colorado, Connecticut, Idaho, Iowa, Kansas, Michigan, Missouri, New York, North Carolina, New Jersey, Pennsylvania, South Dakota, in the Territories of Arizona and New Mexico, and in the "Lake Superior region."

The mines of New Caledonia and Canada supply nearly all of the nickel used in commerce to-day, although those of Norway, Sweden, Germany, Austria and Russia furnish a small quota; but in this country very little, if any, nickel ore is mined now.

The New Caledonian ores are of a higher average grade (6 to 8 per cent. nickel) than those of Canada and are more free from deleterious materials. The extent of these deposits is very great and it is stated that over 120 square miles of nickeliferous territory is being exploited by mining companies in New Caledonia at the present time. The veins are sometimes 25 feet in width, and at places the whole rock is traversed by small seams of ore forming mineralized zones which are mined for a width of over 200 feet. Only the large veins in the solid rock are operated by underground workings, the ore being mostly quarried out of the mountain side. These workings occur at points lying from 900 to 1800 feet above sea level. The New Caledonian ores are what is known as hydrated silicates of magnesia and nickel and are intimately associated with serpentine. They are remarkably pure, containing no sulphur nor arsenic, and are free from copper. These mines can produce very large quantities of ore if there should be a demand for it; in fact there is a tendency toward over-production even now, the value of the stock on hand in 1893 being largely in excess of that of the preceding year.

The Canadian ore-bodies consist for the main part of iron sulphides with which 2 to 3 per cent. of nickel is associated—a totally different character of ore from that of New Caledonia. The nickel is accompanied by copper, which is in one respect a drawback, because the metallurgical separation of these two metals has been always attended with considerable difficulty and expense. The Canadian mines could, single-handed, easily supply the world's present nickel requirements were they called upon to do so, but owing to the light demand for the

metal the large companies at Sudbury for the past couple of years have worked only intermittently, shutting down their smelting works during the winter, and even then accumulating a larger stock of matte on hand than could be profitably disposed of. Various reasons have been advanced to account for the desultory work done at Sudbury, it being even averred that the large companies were purposely depressing the market with a view to "freezing out" small competitors, or for the purpose of discouraging certain stockholders; but the fact of the matter is that the capacity of the Canadian mines for producing nickel far exceeds the present demand for that metal at existing prices. If by means of improved methods of reduction crude nickel, free from deleterious admixtures, were placed upon the market at the present price of copper, and this is quite within the bounds of possibility, the probabilities are that the metal would find a much more extended use, and lead to greater activity at Sudbury, as well as to the exploitation of other nickel deposits now lying idle. Sulphide ores, such as those of northern Italy, Norway and Canada should be very easily and cheaply worked on account of their basic character. Such ores possess many points of advantage over the refractory magnesian silicates of New Caledonia, which in fact are usually converted into the form of sulphides as an intermediate step in their treatment. The same statement applies equally in the case of the rich arsenide and antimonide ores of Austria and Nevada.

The total cost of producing nickel from the New Caledonian ores in 1885 was, according to du Peloux, between six and seven francs per kilogram metallic nickel. The methods employed for extracting the metal from this ore have been materially improved since then; but as the ore is all shipped to Europe for treatment, the cost of transport from interior points to the coast, freight to the European establishments, and subsequent expense in extracting the nickel, have rendered the business a not very profitable one. The cost of producing nickel from these ores has not been very much below the price obtained for it in the market.

In Canada the ore contains copper as well as nickel. Levat estimates that a unit of nickel can be produced from the Canadian ores for about the same price as from those of New Caledonia; but in the former case, when a copper-nickel alloy is admissible, the unit of nickel contained in that alloy costs considerably less. Ever since nickel became the object of systematic reduction in the early part of the present century, its physical qualities have been enveloped in more or less mystery owing to small quantities of impurities being associated with it which very much affect its fusibility, tensile strength, etc. Various investigators have ascribed to it different attributes, not having

clearly comprehended the influence exerted by the presence of small quantities of one element upon large masses of another. The reduction of the metal from its ores has been usually accomplished by secret processes and its passage from the hands of producers into those of consumers is not readily followed. The very quantity of nickel produced in the world is a subject of controversy, different authorities placing the amount at widely varying figures. For instance, one authority places the yearly production of the world for the years 1890, 1891, and 1892 at respectively, 2000, 2500, 4500 and 4000 metric tons, while no less an authority than "Mineral Industry" states that the production for the years named was respectively 2650, 5164, and 6077 tons.

The large increase in the production of nickel during the past few years is mainly due to the introduction of the metal into material designed for war purposes, the toughness of nickel-steel having been found of considerable value in the manufacture of objects which are to be subjected to sudden and excessive stresses. It has been found that steel alloyed with a small percentage of nickel (3 to 4 per cent.) possesses great tensile strength with a corresponding elastic limit. The percentage of nickel used in the alloy has a marked effect upon its physical characteristics, the advantage of steels containing a low percentage of nickel not being found in richer mixtures. For instance, a gun manufactured of steel carrying 27 per cent. nickel did not give satisfactory results, treatment after forging reducing its physical qualities below simple steel.

Up to the present time nickel-steel has met with an extended use only on the part of national governments, such being the inertia of custom that it has not been introduced openly into the arts and manufactures. This is partially due to expense attending its manufacture, partly to a conservative spirit which hesitates to employ a new material, engineers not caring to call for it in their specifications and manufacturers hesitating to advocate its introduction. It is very important for the nickel industry that this nickeliferous iron alloy should meet with a general introduction because in that case nickel would find a ready and ever-increasing market. That such a desideratum can be reasonably looked forward to is foreshadowed in the opinion recently expressed by one of our best authorities on steel subjects who stated in a letter to the writer that the qualities of nickel-steel are simply marvelous and if properly pushed it should have a great future. On this account the future of the metal seems closely bound up with that of nickel-steel and the limited extent to which this material has already been employed has given the nickel industry a considerable stimulus, the remarkable results obtained from physical tests of this material afford-

ing much hope for its ultimate extended use. Although the results obtained in the cases of certain Harveyized plates recently submitted to the Government for testing purposes caused some doubts to be cast upon their effectiveness, still the many tests of a similar nature which preceded the ones referred to and which turned out successfully, and others which have subsequently been made, render it more than likely that in these particular cases failure cannot be charged up against the alloy. As is the case with every new industry, perfection has not been attained at once, and some failures must naturally be expected ; but it has not been by any means demonstrated that the disasters which overtook the particular plates mentioned are to be ascribed to any inherent weakness in the nickel-steel itself. An accumulation of evidence obtained at Krupp's works in Germany, at the Ochata trials in Russia and at the many tests made at Indian Head and other places in this country and in France has been obtained, which goes to show conclusively that nickel-steel plates, when placed side by side with those of ordinary steel, and subjected to severe tests, are capable of withstanding greater punishment than the latter. As stated, this fact has been established upon American and foreign proving grounds again and again so as not to admit of any reasonable doubt remaining upon the subject. However our naval authorities were not satisfied with the resisting powers of nickel-steel plates but wished to carry the matter still further, and to provide for the new war vessels building a material of great surface hardness in addition to toughness so that the projectiles should be broken up on their surfaces, they still possessing the quality of not cracking. If in thus attempting to produce an ideal plate, one possessing the toughness of nickel-steel at the same time with an extremely hard outward surface, it has been found that further experience in the methods of manipulation is necessary before attaining perfection, it is hardly logical to ascribe a casual failure to any inherent weakness in the nickel-steel itself. When it is considered that the presence of 0.1 per cent. of carbon, more or less, in a plate constitutes the difference between a material which will resist cracking, or one which will fly to pieces under the impact of projectiles, the extreme caution necessary in proportioning the ingredients is apparent. Furthermore the effects upon steel of the various processes of annealing, tempering, etc., are factors which demand serious consideration, especially in the case of heavy armor plate subjected to severe test shortly after manufacture.

Apart from the mechanical and chemical processes to which the plates are subjected, the incorporation of the nickel into the alloy during the process of manufacturing the steel may also have a considerable bearing upon the results produced. In France, which was the birth-place of nickel-steel, the method of incorporating the nickel into the bath

was for a time through the medium of ferro-nickel. This material, which corresponds in a measure to the compound of iron and manganese known as ferro-manganese used extensively in the manufacture of steel, was prepared from ores of the two metals and subsequently introduced into the steel bath. This process of manufacturing nickel-steel is explained at length in the patent specifications of both Schneider and Marbeau, and has much to recommend it. It is only rational to assume that where two metals, iron and nickel, are already alloyed in the ferro-nickel, the latter will become very evenly diffused through the steel bath when the ferro-nickel is introduced into it. At present the French manufacturers appear to have substituted metallic nickel in the place of ferro-nickel in manufacturing their nickel-steel; but in either case the nickel is introduced into the steel bath in the metallic form. In this country a different method has been employed by our nickel-steel makers—one which, when the object to be obtained is considered, does not commend itself either upon chemical or mechanical grounds. The nickel is introduced into the steel in the form of what is known as "commercial oxide," and the incorporation of a small amount (between 3 and 4 per cent.) of nickel, in the form of oxide, into a bath of steel so as to form a homogeneous alloy under the conditions named is hardly to be expected. It is difficult to understand how the nickel can become evenly distributed throughout the bath, and if by chance the oxide should not be thoroughly reduced the cohesion of the whole mass is naturally weakened. *A priori* it would appear as though the European practice of incorporating the nickel in the metallic form were the one most likely to lead to uniform results, and the practice of using nickel in the form of oxide may account in some cases for the uneven results obtained over here. The production of alloys is not always an easy operation; but there are other metals forming component parts of alloys in common use, which possess essential characteristics so widely differing from each other that they are much more difficult to alloy than is the case with nickel and iron; yet practice and experience have overcome the difficulties at first encountered. Similarly happy results may be confidently expected in the case of nickel-steel when the manufacturers have gained the requisite experience, and probably occasion to refer to blow-holes or uneven distribution of the nickel will not then arise so often.

One point clearly established by experience with nickel-steel up to the present time is, that as far as applied to large castings the alloy has unquestionably come to stay, but to what extent it can be utilized for smaller articles remains yet to be proved. There appears to be no good reason why it should not eventually find general introduction wherever a tough steel of great tensile strength is required.

The non-corrodibility of nickel would seem to fit it especially for culinary utensils, and these have been placed upon the market for some time, manufactured both from solid nickel as well as combined iron and nickel plate, manufactured in the manner already mentioned. The method of welding nickel to iron and then rolling them both to plate, gives us a material possessing most of the desirable qualities of nickel without its excessive cost. Iron "plated" in this manner does not readily part with its nickel coating, as is so generally the case when it is plated by galvanic action.

Solid nickel coins have recently been issued by some of the European governments, and alloys of nickel and copper, the so-called "nickels" in common use, have long been in circulation in this country and elsewhere; but the uses to which *metallic* nickel is put to-day are comparatively few, and will probably remain so until improvements are introduced for reducing the metal out of its ores.

WHY SOME MEN FAIL AS STEAM-ENGINEERS.

By W. H. Wakeman.

AT the beginning of this paper the writer wishes to define the word "success" as herein used. To attain success as a steam-engineer it is not necessary that a man should secure a position where the highest salary is paid, nor yet where the largest engines are in operation. Both of these are desirable, and we have no desire to belittle them, or to make it appear as if it were an easy matter to attain to them, but we repeat that they are not necessary to success in the work of a steam-engineer. The man who reaches a point where he can truly claim success in this business, has done something more than recline "on flowery beds of ease," for both brain and hand have been as busy as the far-famed bee who "gathers honey all the day from every opening flower." Yes, even more busy, for while the bee retires to rest with the coming of twilight, he who would succeed as a steam-engineer has continued his labors and studies far into the night, and oftentimes rises long before the bee.

If the highest salary and the largest machine are not necessary to success, then what are the attainments that will put a man where he will be satisfied with his condition, or at least as nearly satisfied as it is possible for a mortal to be? In the first place, he must have a salary large enough to enable him to support his family decently and educate his children, and, in the second place, he must be so situated as to be free from unnecessary care and anxiety. It is of this second necessity that we wish to speak more particularly, for it is this which causes a large part of the dissatisfaction among stationary steam-engineers. This statement is made without fear of successful contradiction, for the writer knows whereof he speaks. It is worth while to repeat that it is the unnecessary care and anxiety frequently put upon the engineer that causes him to be dissatisfied, and is responsible for many of the changes in situations so constantly reported among the craft. There are many cares and perplexities that are a necessary part of the engineer's work, and to these the competent engineer does not object, for he expects them to be a part of his regular duties, but when more than this is put upon him, the instinct of self-preservation causes him to look elsewhere for work. If any reader has always believed that men seek new situations solely because they are to receive larger salaries, let me ask why it is that men are often known to go to places where they are to receive less wages than formerly? I have known a steam-engineer to deliberately leave a situation and accept another for a salary 30 per cent. less

than he was receiving. There must be some reason for such apparently inconsistent action. It is not because the care of the engines, boilers, and other machinery proves to be too much of a burden, but because the proprietor or superintendent is more of a burden to the engineer than all of his machinery would be were it multiplied four-fold. There are few proprietors of steam-plants who are practical steam-engineers, yet many of them presume to dictate to the men who feel that they understand their business, and sometimes insist on their engineers doing the most absurd things that could possibly be imagined. Now we are perfectly willing to admit that when a man builds a factory, puts engines and boilers into it, and pays all the bills, he has a perfect right to say how many hours the machinery shall run, to insist that it shall be well cared for in every way and be kept clean and in good repair, that if coal is wasted, or oil and waste disposed of unprofitably, it is his right to call attention to these leaks and have them calked up. But for him to attempt to act as his own engineer is not good sound business policy, and the reason for this conclusion is a very simple one,—namely, because he can hire a competent engineer to do this work much more cheaply than he can afford to do it himself. Some of our best business men are convinced of this and act accordingly, but others are not, and to these a few remarks may be addressed.

If you have a sober, honest, and faithful man in your engine-room, but one to whom you have never given full charge of your plant, commence to place responsibility upon him, cautiously at first, carefully noting how he conducts himself, and, if he proves worthy of your confidence, honor him with greater trust until he runs the plant entirely, and feels that he must demonstrate that your confidence is not misplaced. If he is the right kind of man he will meet you more than half-way, and soon you will wonder how you could have ever been so foolish as to have spent so much time in watching a man whom you called your engineer, but in reality was only your fireman. When this plan is in successful operation, you will be perfectly willing to pay him more wages, because he is actually earning more money for you. Thus you will be better off, and he will have what rightfully belongs to him and will prove a successful engineer. There are many men employed in the engine-rooms of medium-sized plants who are well worthy of such treatment, but, owing to the short-sightedness of their employers, they never receive it, and hence never become successful. A case well known to the writer will serve as an illustration.

The proprietor of a certain factory believes that one small drop of oil per minute is sufficient for the lubrication of the valves and piston of his engine. The man who is nominally the engineer thinks otherwise. If the proprietor comes into the engine-room during the absence

of the engineer and finds more than one drop ascending per minute, he reduces the amount to what he calls sufficient. After a time the engineer returns, finds the oil feeding slower than he knows it ought to, and so increases the feed. This performance is repeated until the engineer becomes exasperated, watches his opportunity, and, when the proprietor alters the feed again, in common parlance, proceeds to "read the riot act to him."

Now if the cylinder of that engine is found to be badly cut and grooved when the machinery is overhauled, who will have to bear the blame? Will the proprietor assume it? If any one supposes that he will, he will find himself sadly mistaken. It is all very well to tell others how well he runs things, and how wasteful the engineer would be were it not for him, but when any damage is done by such mismanagement they are perfectly willing to blame the engineer for it, and, if he protests, will claim that the engineer should have corrected any wrong practice of that kind, as that is what he is hired for. If he has failed to do his duty, he alone is to blame. Furthermore, mechanics and the public in general, when they hear of any such trouble, will agree with the proprietor, and engineers who do not understand all of the circumstances will hold the same opinion. Under such conditions it is almost impossible for any man to become a successful engineer. But the cause of failure does not always lie with the proprietor, far from it. If an individual starts out with the firm determination to become a successful engineer, and goes about it in the right way, it will not be an easy matter for any one to prevent him from becoming one.

The greatest source of weakness is found in the engineer himself, and to some of the primary causes of this lack of strength I wish to call attention, hoping that some one will be benefitted thereby. If it were possible to hire only experienced engineers in all cases it would be well to do so, but while it is true that engineers are "born and not made," still it requires experience and practice to make perfect; therefore some men will always be found in charge of plants who have had but little experience, and who have many things to learn.

Let us take the case of a young man who finds himself in charge of a steam-plant of moderate size. He understands that his principal duties are to shovel coal into the furnace, keep up steam, clean fires, start and stop the engine at the proper time, and keep it clean. He resolves to attend to these duties, and do nothing more. These are what he is paid for, and why should he do any work for nothing? After he has been in charge of the place for some time he meets several comrades in the same line of business, and they begin to talk about their plants. Some questions about back-pressure valves arise,

and he is asked what kind of valve he has and how much weight he carries on the lever. He replies that he does not know, for he never saw it. This valve is located two floors above his room, and is not in his jurisdiction. He never expects to meddle with things that do not belong to him, and will be careful how he gives the boss the idea that he is trying to run the whole shop. Now his listeners put their valuation on his services without delay, and usually it is a proper one. They may not proclaim it in loud tones, for it is far more pleasant to compliment a man than to condemn him, but they understand the situation none the less. Soon cold weather comes on, and the operatives in the factory want steam to warm the rooms. He turns it on, but pays no further attention to the matter. The time comes when they want to shut off the steam from one room for some purpose. They ask the engineer to attend to it for them, but he replies that it is the least of his troubles where the steam goes to after he has got done with it. Again he is requested to tell them what to do or to shut the steam off for them, and, as he has no good excuse for refusing, he goes up into the designated room and simply exposes his ignorance, for he cannot tell where the steam enters or leaves the room. Thus the men in the factory where he is employed lose respect for him, and rate him as an ignoramus.

Again, the time comes when the valve-gear of his engine needs repairs. The proprietor sends for machinists, who come and look the machine over, see what is to be done, make calculations accordingly, and agree to come the following evening and have the job done in time to start up the next morning. During all this time our friend the engineer stands and idly looks on, apparently caring nothing about how the work is done, for he was hired to run the machine, and not to keep it in repair. At the usual time for shutting down on the next day he stops his engine, washes up, and goes home. Just before he leaves, one of them inquires if he is not going to stay and see that the repairs are made according to what he thinks is right. His answer is decidedly in the negative; they can make them as they choose. He is going to an entertainment that evening, and then proposes to take his usual rest. He arrives on time the next morning, finds the repairs finished, and starts the machinery, but how much does that man know about repairing an engine, more than he did the previous week? Nothing at all. These machinists give him a rating according to what they have seen of him and his way of doing business. Does their opinion prove to be of any advantage to him? Quite the contrary.

One more illustration along this line will suffice. The main belt on his engine needs relacing. He does not get a man out of the fac-

tory to help him lace it, but simply reports it to the superintendent, who tells him to stop the engine at noon so that the place where the belt must be relaced will be accessible. This he does, and two men come in and in a great hurry proceed to put on the clamps, cut out the old lacing and put in new, for the power must be running at 1 o'clock without fail. The result is that the belt is not really laced, but is only tied together. During the operation the engineer was eating his dinner, paying no attention whatever to his belt. Did these men respect him and think that he was a great man because he would not assist them? Not at all, for they simply said that he did not know how to lace a belt, and added that they were of the opinion that he never would learn. By what process is this man to become a successful engineer?

In speaking of the above-mentioned mistakes, those have been singled out that represent certain classes, each one of which stands for numerous others of like nature, so that if any reader has not made the particular mistakes to which attention is called, but has made others of the same stamp, he will know what is meant.

There is one blunder, made by some engineers, that deserves to be set apart for special mention. It is the practice of going into a saloon to get a glass of beer to create an appetite for dinner, and, as soon as the day's work is done, to hasten to the same place, where the smell of stale beer and poor cigars makes the air unfit for breathing, and there spending the evening in gaming and drinking, returning home with foul breath and dull brain, to partially sleep off these effects before it is time to begin work again, only to repeat the same practice the next day. I do not wish to convey the idea that engineers as a class are guilty of these bad habits, for they are not, but that some of them are cannot be denied, and we condemn, not the men, but their practice, with a zeal that is deep-seated and uncompromising. If there is any class of men that should be possessed of steady hands and clear brains it is the steam-engineers,—locomotive, marine, and stationary. Why do men allow their appetite for a drink that does them no good, but only harm, to stand in the way of advancement in their profession, and the improvement of their own condition, and happiness of their families?

The writer has just finished reading a chapter written by a friend who has had forty-five years experience as an engineer, and who somewhat facetiously remarks that during that time he has known but two engineers to die, and one of them was drowned. We accept the joke, but would add that while our experience has been of a shorter duration than this, we have known several to die, and more have been promoted to better situations, while some have been discharged for incompe-

tency and bad habits, the consequence being that others must fill their places. Now suppose that some of the friends of the man that we have called attention to hear of one of these places, and make inquiries as to what kind of a man is wanted. They find a good place to work in, and a fair salary offered. In return for this the proprietors want a man to run their plant, attend to all repairs on it, care for the main belt, and see that the heating system is in good repair and working properly. He is not expected to do all of these things himself, but to understand what is wanted, and have them properly attended to, and at the right time. Here is room for a fair question. Can any of these friends go to the proprietor of this plant and recommend this engineer as a man who can fill the bill and give perfect satisfaction? They have no grounds for stating that this is true, for he has never repaired an engine, laced a belt, or studied out the principles on which steam-heating systems operate, and from present indications he will not do any of these things until he is compelled to. The natural consequence is that he is not recommended, and when he finds out that another has secured the situation, he curses his hard luck, and explains to his friends that if he had more money, or a greater "pull," he could get a better place with more wages. But the whole cause of his failure may be summed up in one word—"incompetency."

These are no fancy sketches, but are taken from conditions in real life with which we are in contact every day. Men are not always appreciated, and hence sometimes become discouraged, while in other cases they are not respected, because they do not cultivate qualities worthy of respect. These are the facts in these cases and a study of them will repay the time spent in it, but a dogged denial of them will benefit no one.

THE WHALING INDUSTRY.

By Herbert L. Aldrich.

So little has been heard of the whaling industry during the rush and excitement of the last quarter of a century that many people suppose it to be but a reminiscence. This is by no means the case. The industry was nearly annihilated during the war, but since then there has been a slow but steady increase from a few vessels to a fleet of forty or more engaged in Arctic whaling, and this branch of the service is about all that remains of a business that gave employment to a fleet of over 500 vessels half a century ago.

But now the decline seems to have begun, and with the changes brought about during the past two years, the indications are that sailing vessels cannot much longer make whaling remunerative, and that they must give place to a small fleet of steamers that shall practically live in the Arctic, for periods of two years or more.

Whaling is distinctively an American industry now as it always has been. Indeed there are hardly more than a dozen whalers that do not fly the American flag, and these are Scandinavian vessels, both steam and sail, and English and Scotch steamers which make combined whaling and sealing voyages along the northeastern coast of North America. One or two American whalers also cruise along this coast nearly every year, but they pursue entirely different tactics from the steamers. The steamers follow the whales up into the Arctic as far as it is safe to go, while the American vessels, which are always small brigs or schooners, go only as far north as Hudson's or Baffin's bay where they cruise for a few weeks in midsummer. When cold weather approaches they go into Hudson's bay and freeze up with the ice.

It is rare good fortune if one of these vessels catches a whale outside of the bay, for the success of the voyage is staked on being in the bay in the spring and catching the whales before the ice at the entrance to the bay breaks up.

From a commercial point of view there are three kinds of whales, sperm whales, right whales, and bowhead, or Arctic whales.

Sperm whales have no baleen, or whalebone, but the oil they yield is worth three or four times as much as oil from either of the other whales. They inhabit tropical and semi-tropical seas. When in a certain diseased condition these whales give out an excrement called ambergris that is quite invaluable in perfumery making, and which occasionally sells for fabulous prices, not infrequently as high as ten dollars or more an ounce for choice specimens. But the man who goes sperm whaling

with a view to getting ambergris goes on a fool's errand, as many a whaleman has been on voyage after voyage of three to five years duration each and yet not even seen it.

The female sperm whale, or cow as she is called, is small and seldom produces over twenty barrels of oil; but the male, or bull, sometimes exceeds one hundred barrels in size, as the whaleman's system of measurement expresses it. The bull sperm is the most vicious of fighters among whales, and it is with a great sigh of relief that the carcass of one is hauled alongside the ship, and the boats again hung on the davits, with no damage done to them, and none of their crews killed.

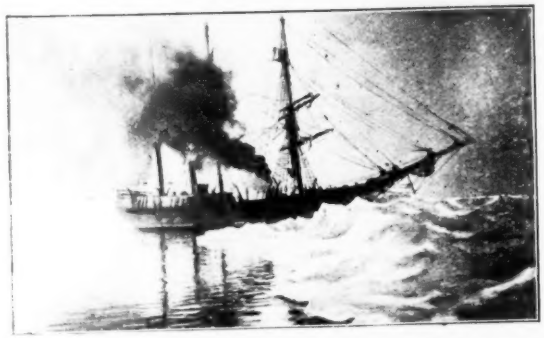
But the danger of the chase is by no means as great now as it was in years gone by, because of the introduction of bomb lances. If one bomb is shot into the "bilge" of the whale, and exploded near the vitals, it will so cripple him that his final "flurry" is short, and death is not infrequently instantaneous.

The right whale occupies the intermediate seas between the tropics and the Arctic, his chief haunts being the waters in and about Bering sea. He averages larger in size than other whales, and unlike sperm whales, the females are usually larger than the males. One hundred and thirty barrels is not a very unusual size for a right whale. But in spite of his size, he is not as valuable as the bowhead whale, since his whalebone is inferior in quality and less in quantity. Otherwise there is no material difference between these whales.

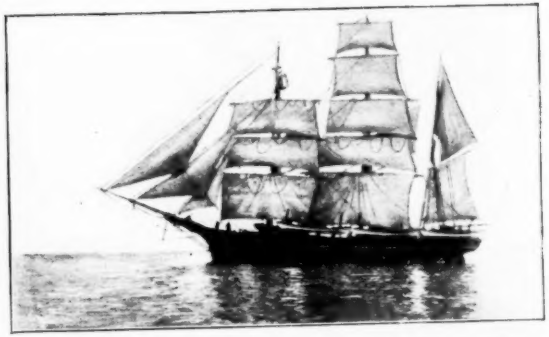
Sperm whaling voyages frequently extend over a period of two or three years, or more, but other whaling voyages seldom exceed eleven months. Nearly all the right and bowhead whalers sail from San Francisco, returning to port about December first to dispose of the season's catch. They are immediately refitted, new crews are shipped, and in a few weeks are at sea again.

When a vessel starts out on its voyage, it goes to a certain "ground." The right whaling grounds of value are the Okotsk, the Kodiak (which is the great bight southwest of Alaska), the Japan sea, and Bering sea. The only bowhead ground is the Arctic ocean and adjacent waters, especially Bering sea and the ocean beyond.

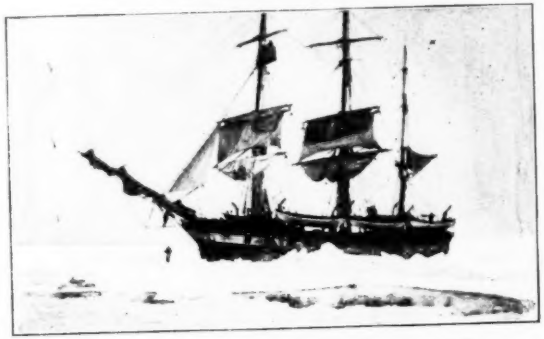
Twenty-five years ago there was a fear that the whales would be exterminated, and this fear came near being realized so far as the sperm whale was concerned, for at that time sperm oil commanded an enormous price, while whalebone and whale oil (the generic term for the oil of other species of whales than the sperm) were in but limited demand. But substitutes have been found for sperm oil so that the demand for it is now small and the price correspondingly reduced. Nothing however has yet been discovered that possesses the peculiar qualities of whalebone, hence its value has risen from a few cents a



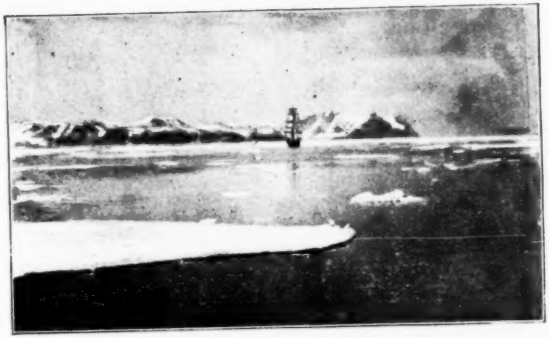
STEAM WHALER IN THE ICE PACK "BOILING OIL."



A TYPICAL WHALING VESSEL.



FROZEN IN THE ICE OF BERING SEA.



WHALING ON THE COAST OF SIBERIA.

pound to seven dollars and a quarter, the highest price yet reached. With this increase in the value of bone, the chase of the whalebone producing whales has been pursued with increased vigor until their numbers have been much reduced, and those remaining have become very shy. The right whales have no safe retreat to flee to, although there are certain bays on the coast of Siberia that Russia has closed to whaling vessels. The bowheads have the Arctic ice as a refuge, but only for a few weeks in midsummer, as the same gales and cold which drive the whaleships out of the Arctic also drive them out.

The bowheads spend the winter along the edge of the line of ice in Bering sea, but early in the spring they push northward through the ice pack as it breaks up and opens the way for them into the Arctic. But the same conditions that make it possible for the whales to go into the Arctic also make it possible for the whaling vessels to go, and in this "outside whaling," as the Bering sea whaling is called, the fleet usually makes a catch of from twenty-five to fifty whales.

After the whales enter the Arctic they scatter along the edge of the solid north pack. Usually most of them go far into the northeast, up to, and beyond Point Barrow if the sea is free enough from ice. But occasionally the whalemen search these waters without finding evidences of a whale. This makes them apprehensive lest the season in the Arctic shall be a failure, so they head their vessels westward, beat along the edge of the pack, and usually find the great body of the whales somewhere between Point Barrow and Herald island. In the year 1887 when I was in the Arctic as the guest of the fleet, whaling became very "dry" about Point Barrow, and the sailing vessels, which stood small chance of making a catch when the steamers pursued closely the few whales that were seen, went westward.

The long absence of these vessels, and the final disappearance of all whales at the eastward, led the masters of the steamers to conclude that their fellow masters of the "wind-jammers," as the sailing vessels are called, had made a wise move, and they followed after. The master of the steamer *Orca*, which I was on board of at the time, ordered steam up, and we followed along the edge of the pack far into the northwest of Herald island, only to be rewarded by encountering a terrific gale which lasted for several days. Returning again toward the eastward we found the whales, and in a few days were "high-hook," having caught twenty-eight whales, the best record that has ever been made by one vessel for so short a season in the Arctic.

Before the gale scattered the whales the sailing vessels had also made good catches of six or eight whales each, so that altogether the "season" was one of the most profitable in the history of Arctic whaling.

The low price of oil, which averages perhaps five hundred dollars to the whale, and the enormous increase in the value of whalebone, which reaches about four thousand five hundred dollars per whale, has led some captains to save only the whalebone of each whale killed, then cut the carcass adrift. The indications are that this system of whaling will soon become quite general. If it does, whaling will be shorn of its most interesting feature and be reduced to mere whale-butchering voyages.

I cannot better describe the operation of capturing a whale and "cutting-in" than by depicting the most exciting whaling scene of the dozens that I witnessed.

Eight vessels, two steamers, and six sailing vessels were at anchor in the bight under Cape East, Siberia. This is the easternmost extremity of Siberia and is at the narrowest part of Bering strait. The vessels lay at anchor along some shore ice. Two "lookouts" were aloft in each "crow's nest" watching for the appearance of any whale that had the temerity to attempt to pass by into the Arctic.

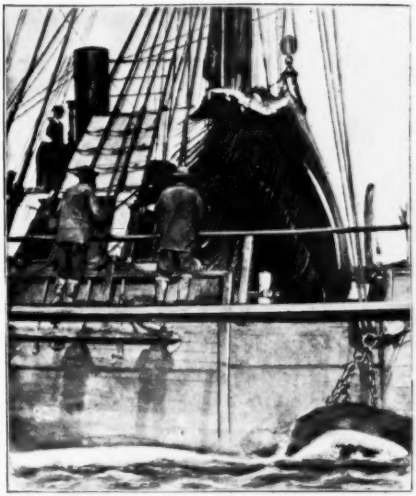
Immediately after dinner one day the "lookout" on the southernmost vessel raised the cry of "b-l-o-w-w." The echo of his call had scarcely died away before the whaleboats of this vessel dropped from the davits into the water, set sail, and scattered about to watch for the next appearance of the whale. Boats from the other vessels were not far behind, and within five minutes from twenty-five to thirty white sails were darting about over the water, each boat's crew hoping to be nearest the spot where the whale should rise to blow. Neither a paddle nor an oar is ever used in the chase, as the hearing of the whale is so acute that danger would be scented at the first touch of the water with them.

The "lookouts" on the several vessels were signalling to their boats with flags, directing them as to how they should maneuver. But it was all guess work. No one could even approximate the spot where the whale would rise.

Six captains and I had been dining on the northernmost vessel, the *Narwhal*, and we had just come on deck when the whale was "raised." With but one long-glass to go around, we took turns in watching the scene of action which was some three miles away.

A great shout came from all sides, and a "b-l-o-w-w" sounded from each "crow's nest," as the whale's head appeared above the water within striking distance of one of the *Lucretia's* boats. There was a quick maneuver; the boat-steerer darted his harpoon into the whale, and "fast boat," "fast boat," resounded from every vessel.

It was a magnificent sight as the whale milled about and started out to sea at a high rate of speed, towing the boat after him. The



"HURRAH FOR FIVE AND FORTY MORE."

TYPICAL DRESS OF A WHALING MASTER.

A WHALEMAN WITH DARTING GUN, HARPOON WITH LINE ATTACHED, SHOULDER GUN, LANCE, AND CUTTING SPADE.

WHALEBOAT IN THE ICE.

boat steerer had struck the whale abaft the vitals and only wounded him, so that it was yet far from certain whether he would be captured.

The whale went out to sea two or three miles, towing the boat at such speed that it did not ride over the waves but cut through them, throwing spray like a torpedo boat. Then he turned about and doubling his wake, sought the protection offered by the shore ice near the ships. Probably half the whales that are wounded in the Arctic regions escape by taking to the ice, either because the boats cannot follow them into the ice, or because the lines become tangled among the rough edges on the under side of the ice, and perhaps cause the "irons" to "draw."

The instant the whale headed shoreward four of the captains and I took the only steam whaleboat in the fleet and joined in the chase, as there was little hope of saving the whale unless more bomb lances could be shot into him, and as yet not one of the other boats had had opportunity to shoot him.

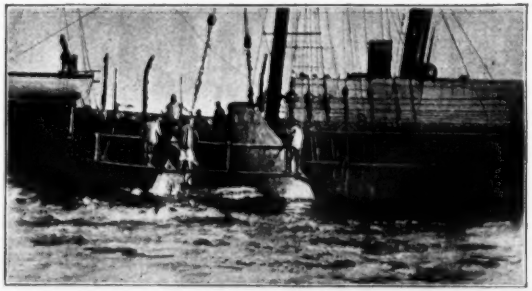
At the north end of the floe was a bight in the ice. The whale passed in under the ice and suddenly appeared in this bight to "blow" for the first time since he was struck. Before he could "sound" our boat had steamed around into the bight and was alongside of him.

The captain of the *Lucretia* stood in the forward end of the boat with shoulder gun in hand ready at the proper instant to shoot; and the master of the *Eliza* stood amidship, also with gun in hand. It was only for an instant that we saw the whale as we steamed past at a high rate of speed. But the captains were alert. There were two loud reports that almost deafened us, and that made the boat tremble from stem to stern. The whale gave a sweep of his flukes through the air as the bombs exploded, and rolled over, dead. The sweep of his vicious tail was a second too late to hit the boat, and we caught only the swash of the subaqueous convulsion as we rushed by.

When the whale is dead the excitement ends and the hard work begins. The boats of the ship to which he belongs "hook-on" to him, and tow him alongside of the vessel. His head is placed just abaft the gangway, and great "fluke chains" are fastened around his flukes; then the work of cutting-in commences.

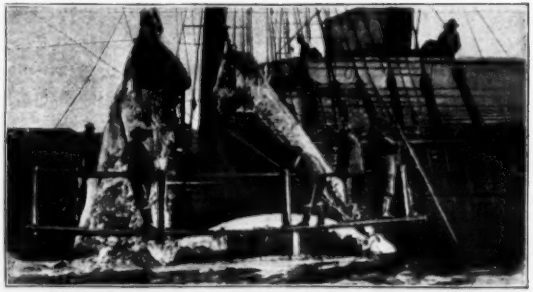
The "head," or what would commonly be called the upper jaw, is the most valuable part of the whale because it contains all the whalebone, and there is much anxiety on the part of the crew until it is cut off and landed safely on deck.

The manner of cutting this off usually depends upon the position in which the whale lies. If in one position it is necessary to cut off one lip, and possibly the throat, before the "head" is reached; if in



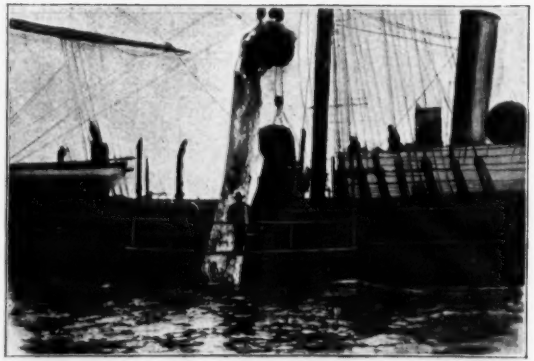
CUTTING OFF THE THROAT OF THE WHALE.

STARTING THE "BLANKET PIECES."



CUTTING OFF A LIP OF THE WHALE.

A "BLANKET PIECE."



another, both lips and the throat have to be cut off. Sometimes the carcass can be rolled so as to bring the "head" uppermost. In either case, the spinal column is cut in two with axes where it unites with the skull, and when with a final jerk the two parts separate, and the "head" is safely landed on deck, there is a suspension of work, and all hands throw up their hats and shout, "Hurrah for five and forty more!" When oil was the prime object of the whaleman's search this time-honored shout of victory was reserved until the flukes came over the rail, but now that whalebone is the object of the voyage, the place of rejoicing has been changed from the tail to the head.

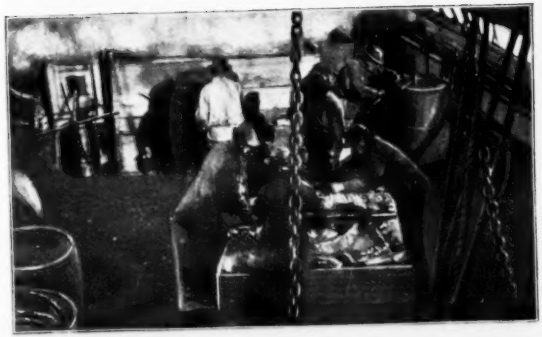
The "head" is put one side until the blubber is all cut off the carcass, then the slabs of whalebone are carefully separated and stowed away to be scraped, washed and cleaned later on.

The operation of cutting-in the whale lasts about an hour, and, after the "head" is removed, is not difficult unless there is a heavy sea rolling. A "fin chain" is fastened around the uppermost fin to start the "blanket pieces." Keen edged cutting spades are used by men standing on a staging suspended over the whale, with which they cut the "blanket pieces" into strips a yard or so wide and separate the blubber from the "lean." This operation is not unlike that of cutting the peel off an orange in strips, and separating it from the pulp by means of a sharp knife. The "blanket pieces" vary in length from twenty to thirty feet, and as each one is cut off it is hoisted on deck and dropped down into the "blubber room" which is the space between decks, between the main-mast and the foremast. As soon as the cutting-in is completed, the work of "boiling" usually begins.

Two or three men go down into the "blubber room" and cut the "blanket pieces" into "horse pieces." These are strips about ten inches square and a yard or so long. These "horse pieces" are in turn "minced," that is, sliced with keen edged "mincing knives," after the manner of cutting a loaf of bread into slices, then they are ready to go into the great deck pots to boil.

It is like a vision of the infernal regions to see a whaleship "boiling" at night. The only light comes from a "bug-light," a wire basket of a capacity of a bushel or so suspended immediately over the try pots, and filled with "scraps" which are pieces of blubber from which the oil has been tried out, and which have been skimmed from the deck pots, and perhaps been put through a press to still further extract the oil from them. The "bug-light" flickers in a most lurid way, and gives the whole scene a weird and uncanny appearance.

Standing above this scene on the quarter deck and looking down upon it under the glow of the light, one can readily imagine himself in the nether regions of darkness. In the foreground are the men who



SCENE ON DECK DURING "TRYING-OUT."

TENDING THE TRY POTS.

MINCING THE BLUBBER.

DECK SCENE WHEN WASHING WHALEBONE.

do the mincing, cutting away monotonously, and perhaps to the rhythm of a subdued song. Another man is hurrying to and fro carrying the minced blubber to the try pots. Two men tend the pots, and at short intervals reach into the darkness for what appear to be huge pitchforks similar to that which His Satanic Majesty is represented as wielding. With these they reach far down into the pots, and stir up the oil, then raise them high into the air toward the "bug-light," and examine closely suspicious looking objects dangling from them.

Then they open the doors to the fire chambers and shovel in "scraps" to feed the fire. There is a rush and a roar of flame which lights up their besmutted faces, and which crackles fiendishly. And as the doors are closed again, a cloud of foul smelling black smoke pours from the stacks, dimming the illumination of the blazing "bug-light," settling all over the deck, and penetrating into the inmost corners of the cabins.

It is a glimpse of the lower regions more vivid than Dante could describe or Doré depict.

Every year brings a gradual disappearance of much of the excitement and the picturesqueness in whaling. Just as steam, armor plate, and big guns have made modern war vessels mere engines of destruction that have no grace and have displaced human courage and skill with human machines, so steam and powerful explosives are making whaleships into mere whale-killing machines.

The rugged character and sterling seamanship of the whalemen of years gone by was due to the fact that the ranks were recruited from some of the best blood of New England. But this has all changed, and this industry which once offered rapid promotion and early fortune, now offers but an uncertain and precarious livelihood.

Half a century ago the whaling service was one of the great civilizing agencies. It opened the way for missionaries to Christianize fierce and cannibalistic tribes, and for traders and settlers to teach them the vocations and arts of civilized communities. It gave us illumination for our homes and our light-houses; it lubricated the wheels of industry, and in the trying time of war it manned the vessels of our navy with their bravest and most efficient seamen.

Now the whaleman is no longer an important factor in the industrial world. All corners of the seas have been explored. The low price of oil would have retired years ago every vessel engaged in the fishery had it not been for the stimulating effect of the steadily increasing price of whalebone. But the supply of bone is far too small to satisfy the demand, and the price for what there is in the market is so high that it is only a question of time when some substitute will be discovered that shall displace it.

THE GREAT DAM AT AUSTIN, TEXAS.

By Frank E. Snyder, C. E.

TEXAS can well lay claim to the "Second Niagara," in the falls created by the great dam in the Colorado river at Austin. The river just above Austin emerges from between high hills, having traversed a distance of over 400 miles from its head-waters. Spanning this cañon the city of Austin has built one of the largest masonry dams in the world. The clear length of spillway reaches 1090 feet,—head gates and bulkheads 270 feet—a total length over all of 1360 feet; height from foundation to crest 68 feet, raising the water 60 feet above low-water mark. The one thing making this dam notable above other large masonry dams is not its great size alone, but that it spans a large river subject to tremendous floods, when the dam will have to pass a depth of 15 feet of water over its crest.

The utilization of the power of this stream by the city of Austin had long been agitated and was finally brought before the city government in a message by the mayor, Mr. John McDonald, early in 1890, resulting in the selection of an engineer—Mr. Jos. P. Frizell. M. Am. Soc. C. E., of Boston, Mass.,—to examine and report on the project. Mr. Frizell's report was presented in March, 1890, supplemented by a report from Mr. John Bogart, State Engineer of New York, as consulting engineer. Both reports favored a 60-feet dam as best suited to the location and to the development of power for the operation of an electrical and waterworks plant for the city, and to have reserve power for manufacturing plants. The estimated cost was $1,400,000.

Funds were at once voted, and a board of public works created to handle the work, which was begun in November, 1890.

Mr. Frizell had prepared the plans and was appointed chief engineer. The construction of the dam alone occupied 2½ years. It cost $611,000. The first illustration shows the completed dam as the last stone was being set on May 2, 1893. The overhead cableway for transporting all the material, designed by the Lidgerwood Company of New York, and which occasioned much comment as to its efficient work, is shown in the cut. The blocks of masonry were hoisted from the cars, carried, and lowered directly into position in the dam by means of this cable.

Texas has an inexhaustible supply of granite in the quarries near Austin,—the same from which the Texas State Capitol was built some years ago. This granite was used for both faces of the dam and the core was made from limestone quarried right at the dam. The total

quantities used were 20,650 cubic yards granite, and 70,650 cubic yards limestone masonry. The whole work was laid with Portland cement mortar.

The lake formed by this dam is 25 miles long, covering an area of 2000 acres.

Estimating the available water power Mr. Frizell reported the following: "The drainage basin of the Colorado above Austin is some 40,000 square miles in area. It lies between the parallels 30 and 34. Snow rarely falls, and there is no distinctly rainy season The average annual rainfall of the basin so far as I can learn is 25 inches. . . . . The river is subject to great rises in times of heavy rains. On the cessation of the rains it falls rapidly until it attains a minimum flow which appears to remain nearly constant. . . . . This flow is nearly 1000 cubic feet per second. Upon this flow the total amount of power available for driving machinery equals 5227 horse-powers constantly."

For the 60 working hours of the week Mr. Frizell estimates 14,000 horse-powers available per day of 10 hours.

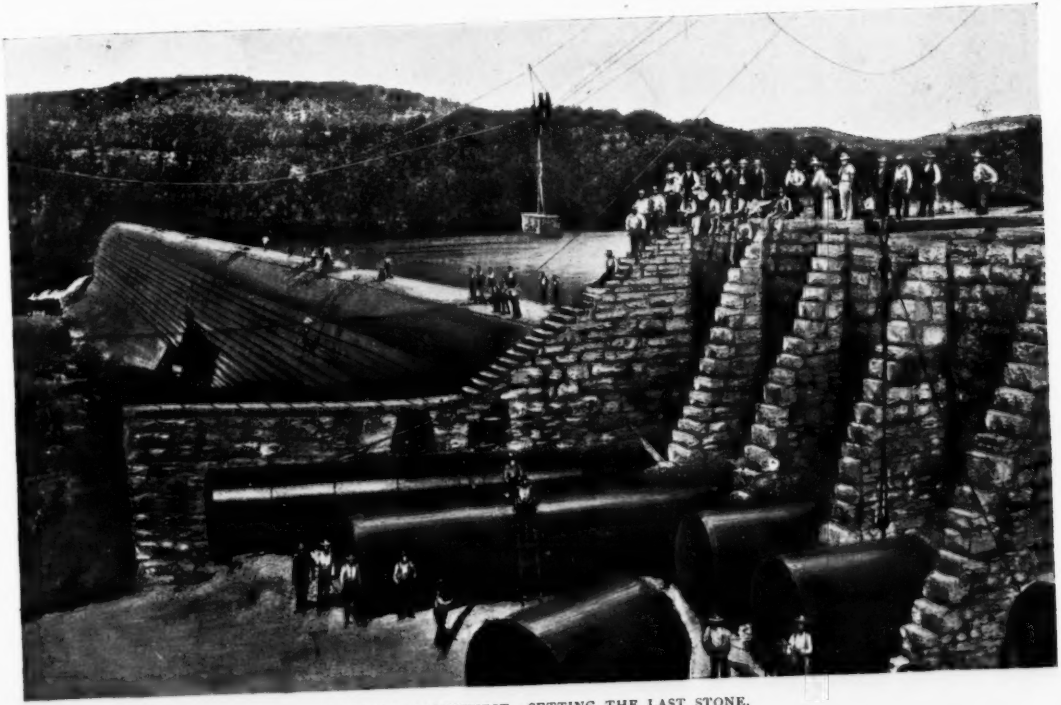
Mr. J. T. Fanning, M. Am. Soc. C. E., reporting on this same work estimated that the city would have a surplus power, above that required for its own service in electrical work and waterworks, of 3950 horse-power or something over 9000 horse-power for the 10 working hours of the day.

Commenting on the amount of work this represents, Mr. Fanning quotes as follows:

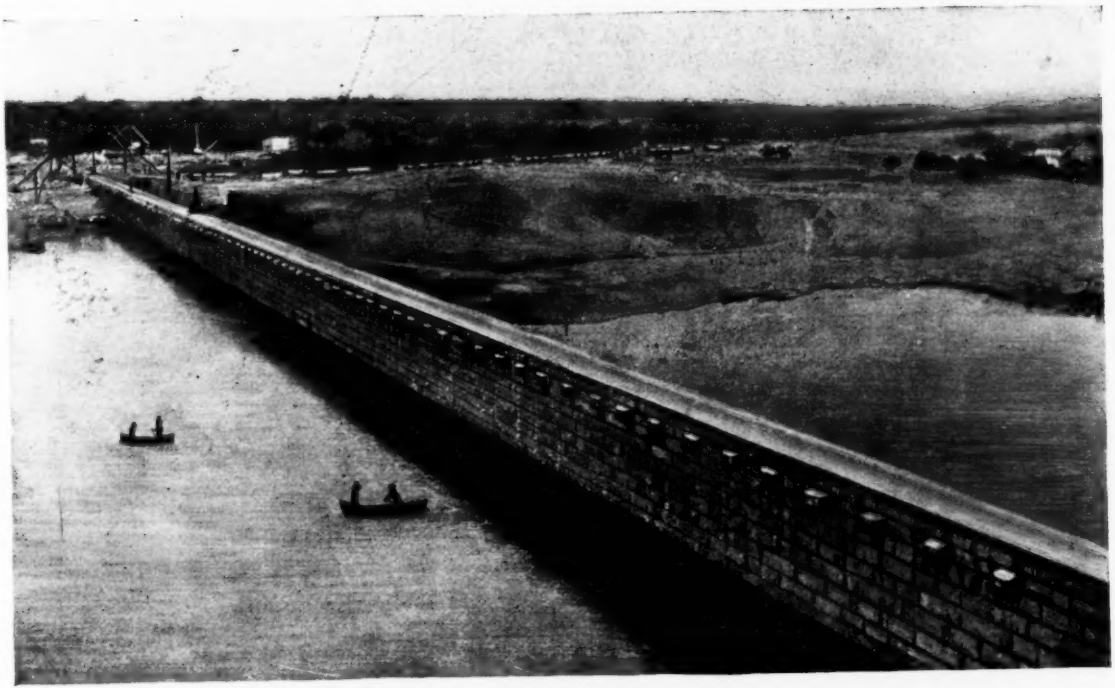
"One hundred horse-power is sufficient for a large machine or implement shop; 450 horse-power will run a cotton mill with 50,000 spindles on cloths adapted to the local jobbing trade, and 400 horse-power will run a wheat flour mill of 1000 barrels capacity, or an equivalent corn meal mill."

The power plant now being erected for the city is situated immediately below the head gates on the east bank or city side of the river. Seven iron penstocks, 9 feet in diameter are set in the head gate masonry to convey the water to the wheels. The water is controlled by large sliding gates, working in vertical guides, operated from the top of the wall. Four of these penstocks will be used by the city of Austin, leaving three to be used for private industries.

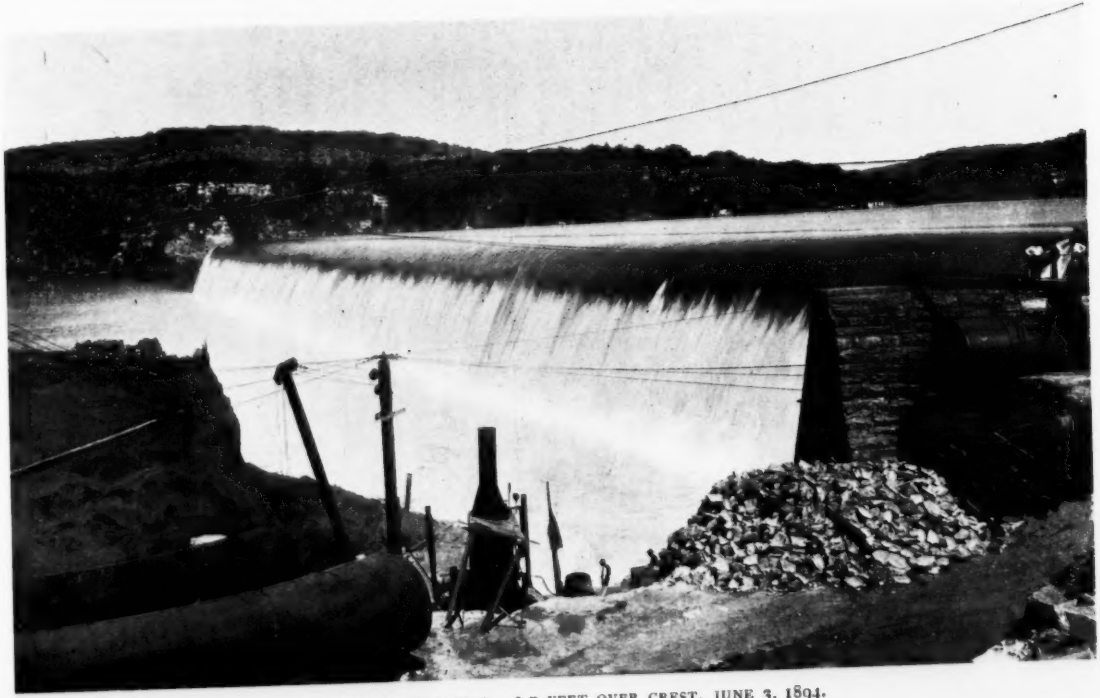
This plant when complete will be one of the largest in the southwest. There are two vertical turbines and four pairs horizontal turbines aggregating nearly 2500 horse-power. The vertical wheels will drive the pumps, and the horizontal wheels the electrical machinery. The waterworks system comprises about 30 miles of mains, being supplied by two 4,000,000 gallon pumps. The electrical plant supplies a



LOOKING NORTHWEST—SETTING THE LAST STONE.



THE UP-STREAM FACE.



DAM AT AUSTIN, TEXAS. 3.7 FEET OVER CREST, JUNE 3, 1894.

street lighting system of two-hundred 2000-candle power lights, with a reserve power sufficient for 15,000 16-candle power incandescent lights, and an aggregate of 500 electrical horse-power for motor and street railway work.

The completion of the power plant was delayed about a year by a serious break in the eastern bank of the river encompassing part of the power house site, and breaking down part of the head gate masonry. This has been rebuilt, and it is expected to have the plant in operation in a few months. The break was due to a fault in the limestone bluff into which the head gate masonry abutted.

The city issued and sold $1,400,000 worth of 5 per cent. bonds to build this work. The estimated annual revenue is put at about $150,000, when in operation.

Commenting on the influence which this water power would have on this district and Austin, Mr. Fanning quotes the following: "Central Texas is now entering an industrial era. I read that the recent geological surveys show several large areas in the state to be rich in minerals, including coal, copper, galena, silver and certain valuable mineral earths; and these will give a new direction to local energies and investments. The rich ores may be here treated electrolytically by aid of this water power. . . . . Austin is in the heart of a rich belt where raw products can be economically supplied in almost inexhaustible abundance if a market is assured for them through this mechanical line. . . . . This great water power is worth its cost for pumping the city water supply and giving the power for the city's electrical works." Mr. Fanning is the present consulting engineer and Mr. Jos. Kepferle, engineer in charge of the work.

The lake, named "Lake McDonald" in honor of the mayor and president of the board of public works, has become quite well known for its aquatic facilities, an international regatta having been held here in 1893 and 1894, at which were all the famous oarsmen of the world, some records being broken by the time made on this course. The lake is equipped with large steamers, and the place is becoming well known as Texas' Chautauqua.

THE WORLD'S GOLD PRODUCTION.

By T. A. Rickard, F. G. S.

IN a former number of this Magazine * the writer endeavored to prove, by a reference to statistics and other facts, that the difficulty of winning gold was, owing to the exhaustion of the more shallow and more accessible deposits, daily becoming greater. Since the preparation of that contribution much has been written regarding the sources of the world's gold supply. The subject is one of particular moment not only to that small and energetic fraction of the community engaged in mining but also to that far greater and ever-increasing number of persons to whom it is evident that the future well-being and prosperity of this and other countries depend upon the right solution of the great problem of our time—the monetary question.

The collapse in the market value of silver which took place in June, 1893, caused a check to all mining enterprise, a check which was however temporary in so far as it affected the search for metals other than silver and was followed by an increased activity in the winning of that metal whose value events had not depreciated but rather enhanced. The marked impulse thus given to gold mining has put a vitality into the industry which has led to increased exploitation in old districts and to renewed exploration in undeveloped regions. The results are already made manifest by the figures which give the yield of gold for 1893.

The director of the United States mint gives the world's production in 1893 as 234,006 kilos or 7,523,362 ounces, valued at $155,521,700. The figures for the previous year are stated to be 220,133 kilos or 7,077,146 ounces, valued at $146,297,600. The amount credited to 1892 by Mr. R. E. Preston—the new director of the mint—is considerably greater than that given by Mr. E. O. Leech, the former director. The difference is largely due to the fact that the former does, and the latter does not, include China among the gold producing countries. Mr. Preston estimates China's production in 1892 at 12,678 kilos of a value of $8,426,039.

According to the most recent statistics the production of the world during the last three years has been:

1891.....	196,586	kilos	valued at	$130,650,000
1892.....	220,133	"	" "	146,297,600
1893.....	234,006	"	" "	155,521,700

In his latest report the director of the mint comments upon these

* December, 1893.

figures and points out that the value of the gold product in 1893 was only 8.77 per cent. less than the average aggregate value of the gold and silver produced in the years 1861 to 1865, which Dr. Soetbeer estimated at $170,473,383. It may be pointed out however that in the year 1853 the world's output of gold was no less than that for 1893. Mr. Preston expects the yield for 1894 to reach about $190,000,000, an amount equal to the value of the world's production of both metals, gold and silver, twenty years ago. The average annual production of gold and silver was, according to Soetbeer, as follows:

1856–1860....	Gold	201,750 kilos.	Silver	904,990 kilos.
1861–1865....	"	185,057 "	"	1,101,150 "
1866–1870....	"	173,904 "	"	1,969,425 "

while in 1893 according to the mint report the gold produced was 234,006 kilos, and the silver, 5,002,294 kilos. These figures prove that the comparison made by the director between the gold of 1893 and the gold plus silver of twenty years ago owes its interest mainly to the fact that the silver production has enormously increased and not so much to the decrease in gold production.

This fact he considers must exert a powerful influence on the monetary policy of all civilized communities. Continuing this line of thought he estimates the *minimum* value of the world's output of gold in 1895 at $183,842,000 and in 1896 at $200,000,000.

The director of the mint therefore confirms the idea which is prevalent to the effect that the production of gold not only locally but also generally the world over is destined to a marked increase, an increase so great as to play a serious part in the determination of the choice of a monetary standard. Expression has been given to this idea in many organs of public opinion. The writer's knowledge of the conditions of the gold mining industry in the regions which are the chief contributors to the world's supply leads him to believe that such an idea is unwarranted by the experience of the past and opposed to the facts as they exist to-day.

A brief reference to the four leading gold producing countries will be required before further discussion.

The United States during the last three years has produced gold as follows:

1891.....	1,604,840 ounces.	$33,175,000
1892.....	1,597,098	33,014,981
1893.....	1,739,700	35,959,599

In 1893 the chief increase came from Colorado, which produced $7,525,000 as against $5,300,000 in 1892. The production for 1894 will undoubtedly show a further increase. That increase will prove a very important factor in advancing the prosperity of the state, but it

will in no way be of such magnitude as to be of any moment in augmenting the world's production or in influencing the course of financial legislation. Much has been made of the extraordinary growth of the amounts of gold deposited at the Denver mint. It is not generally known that two of the large smelting establishments which formerly forwarded their bullion to the east to be refined now send it to the Denver mint. This is an example of the way in which statistics can prove misleading.

From 1848 until 1893 California has held the first position among the gold mining regions of America. At the present time Colorado bids fair to surpass the golden state. For the last four or five years the yield of California has been practically stationary at 12 to 12½ millions. In 1893 there was no noteworthy increase. Much has been said by fervid Pacific coast writers regarding the enormous increase in the gold yield which would result from the reopening and operation of the large alluvial mines (worked by the hydraulic process) which had been closed down on account of debris legislation and were to be restarted under the Caminetti Act. It was stated that the resumption of work would add from $15,000,000 to $25,000,000 to the production. As a matter of fact statistics show that the closing down of the alluvial mines of the Sierra Nevada decreased California's yield from 6 to 8 millions per annum.

The passage of the Caminetti Act has not sufficed to thoroughly reanimate alluvial mining in California. It will not serve to do so. The margin of profit in the carrying on of operations and the difficulty which yet exists on account of the terms of the Act are the one so small and the other so great as to prevent the full resumption of work.

Only a few mines have resumed operations. The building of impounding dams—required by the new law—is in very many cases, owing to the topography, impossible. In other instances the mines do not warrant nor have the owners the means to justify the incurring of such an expenditure. On the whole, therefore, it is safe to say that it is extremely improbable that California's gold output will, either now or in the near future, be seriously assisted by the output of the alluvial mines which were closed down in the years succeeding 1882.

While the days of extensive alluvial mining are on the wane, vein mining is characterized in California by the prosperity which follows upon successful development. But in this instance, as is the case elsewhere, the yield of the new mines is barely able to compensate for the exhaustion of the old ones, and there is no such lavish output as characterized the days of placer mining on the Yuba and American rivers.

In the other states of the Union where gold mining is carried on—

Dakota, Montana, Idaho, Arizona, etc.,—there is a prospect of increased activity which will compensate for the diminution in the yield caused by the closing down of silver mines which also produced gold. In a general way it is certain that there is in the United States to-day a noteworthy increase in the search for gold; this is manifested in the reworking of abandoned placers, the reopening of old mines and an active prospecting whether for alluvium or veins. The results of this activity are exaggerated. The ordinary local newspaper may talk in a manner half poetic and half hysteric of the "boom" in its own section. These things are of small moment. In most cases the increased work on gold producing mines will barely compensate for the loss in the total yield due to the cessation of work in properties which formerly produced both gold and silver. The temporary renewal of activity often only means the nearer approach of a complete exhaustion of surface gravel and shallow deposits of every kind.

The gold mining industry of the United States is destined to a future of great usefulness and ever-increasing economic importance, but the writer does not believe that the average annual production for the next ten years will much exceed the average of the last decade.

Australasia was the largest gold producer of the world in 1892 and 1893. Last year the output amounted to 1,876,562 ounces valued* at $35,654,678. These figures indicate an increase of 80,432 ounces or $1,528,208 over 1892. Of the total increase no less than 51,342 ounces is to be attributed to Western Australia, a country which until recently has been the most backward and least developed of all the colonies. The output of Victoria, which is to Australasia what California is to America, increased from 654,456 ounces to 671,125 ounces. Queensland and New South Wales exhibit a slight increase while South Australia, Tasmania and New Zealand produced less than in 1892.

There is no reason to anticipate any noteworthy increase in the production of these colonies. The discoveries made during the past twelve months at Coolgardie, Southern Cross, and other new camps situated amid the desert lands of Western Australia are not of such a character as to have more than a local importance. Their development will always be hindered by great natural obstacles, the chief of which are the want of water and the scarcity of mining timber. The increase in the production of Western Australia which will follow from the working of the most accessible surface deposits will be barely sufficient to balance the decreased output of the more important colonies.

In Victoria the deep mines of Bendigo† are not doing so well this

*I estimate the value per ounce at an average of $19.

†Bendigo has 27 vertical shafts exceeding 2000 ft. in depth. The "180" mine is 3100 ft. deep.

year as in 1893. The rich finds recently made near Daylesford and the discoveries of alluvial ground at Huntly, Wedderburn and elsewhere will scarcely offset the gradual exhaustion of the deep leads of Creswick and Ballarat. In New South Wales some discoveries have recently been made, as the result of increased activity in prospecting, but they are not of far-reaching importance.

The mining industry of the colonies is in a healthy and vigorous condition; the injury done to silver mining at Broken Hill by the collapse in the price of the white metal will be balanced by renewed energy in gold mining; but this again, while important to the country itself, will not be such as to play any important part in the world's business.

Russia produced 38,822 kilos or 1,247,156 ounces, valued at $25,801,645, in 1892. The figures of the output for last year are not yet available.

It is very probable that Russia's annual yield will begin to decline in the near future. Such a statement is based on the fact that the center of placer mining has been moving steadily eastward, from the Ural mountains to the coast of the Pacific. The first discoveries were made at Ekaterinborg in the Urals, and operations have been gradually extended eastward as new districts have been successively discovered, developed, and exhausted. The bulk of the yield of the Russian empire now comes from the Amoor river, from Nerchinsk and other districts in the remote eastern provinces of Siberia. The mines in the Urals, the diggings on the Yenesei, those on the Olekma, have each in turn been the scene of greatest productiveness and each in turn has given place to some newly found region further from Europe. As was said by Striedter more than ten years ago—"the sea is set as a barrier to the further migration of the production of gold."

But, it may be objected, surely with the rapid improvement in gold extraction new methods will render available the old abandoned diggings. Prof. Suess has pointed out that the reworking of the tailings of the old mines by the aid of improved processes and greater technical knowledge is not to be relied upon for any considerable addition to the production. It is too late to introduce them, as has often been found out by enthusiasts in this and other countries, when the gravel has once been turned over.

There are therefore no facts which warrant the expectation that Russia will be able in the coming decade to add to the average of her present annual output.

Africa, the new El Dorado of the south, remains to be considered. In 1893 the output of the Witwatersrandt in the Transvaal amounted to 1,478,477 ounces, while the total output of South Africa was 1,610,-

046 ounces, which, taking the gold at 850 fine, gives a value of $28,272,407.

The increase over 1892—equal to a money value of about six million dollars—was due almost entirely to the mines of the district of which the town of Johannesberg is the center. This region contains a series of beds of gold-bearing conglomerate—called banket reefs—which have been developed with extraordinary rapidity during the past five years. In 1893 certain bore holes were put down with the aid of the diamond drill and the continuity of the deposits was proved by the discovery of gold-bearing material at a depth of 2400 feet. The increase in the year's output amounted to 267,610 ounces. For the first six months of 1894 the yield has been 973,736 ounces or 779,000 fine ounces, an increase of 46.4 per cent. over the same period last year. At this rate the output for the present year will reach 1,600,000 fine ounces.

If the world's gold production is to undergo an increase such as is predicted by the director of the mint and other authorities, then South Africa will be the region from which this increase may be expected. But, while in no way underrating the marvelous growth of the mining industry of the Randt and thoroughly appreciating the enormous extent of gold-bearing territory which there exists, the writer believes that, as has been the case many a time in other newly developed districts, the estimates formed have been too much tinged with that sanguine spirit which must ever characterize successful mining, but which must be eliminated in the study of statistics. The following figures will be of value:

Year.	*Tons produced.*	*Gold yield.*	*Average per ton—dwts.*
1887		23,155	
1888		208,121	22.65
1889		369,557	19.60
1890	702,828	494,817	13.36
1891	1,154,145	729,238	11.23
1892	1,979,354	1,210,867	10.20
1893	2,217,843	1,478,477	10.09

The above statement, while it forcibly illustrates the great growth of the output, also emphasizes the fact that the yield per ton is decreasing. In May, 1894, the output was 115,466 ozs. 4 dwts.* from the treatment of 243,217 tons, giving an average yield of 9.5 dwts. per ton. It will be noted that the average yield as above given does not agree with the tonnage and total gold production. This is due to the fact that the extraction of gold from accumulations of old tailings has

* Plates and concentrates. The tailings are excluded.

added very considerably to the output. Thirty per cent. of the yield of the Witwatersrandt comes from the treatment of tailings by the cyanide process. This source of production is very limited.

The steady decrease in the yield is due to the exhaustion of the bodies of higher grade free milling ore occurring near the surface. As depth is gained the ore becomes pyritic, its gold contents tend to decrease and the cost of its reduction in the mills tends to augment. The Robinson mine in 1893 treated 94,842 tons of ore and produced, excluding tailings, 114,882 ozs. 15 dwts. of gold. These figures are exceptional. The character of the mining of the region is better indicated by the results achieved by the Langlaagte estate and Crown Reef companies. The former obtained 74,860 ozs. 3 dwts. from 222,732 tons, giving an average of 6.7 dwts. per ton. The latter obtained 52,411 ozs. 2 dwts. from 118,244 tons, giving an average of 8.8 dwts. per ton.

The great increase in the output during the past three years is traceable to the erection of new and large mills; it is also due to the successful treatment of accumulations of old tailings which owing to the bad milling of the early years are so rich as to make them profitable of treatment now. Both these factors will shortly cease to operate, a halt will be called in the erection of new mills and the tailings heaps will become exhausted. In the meantime the steady operation of the mines will be followed by the working out of the upper levels with their less refractory and better ore, leaving for the future the enormous masses of low-grade pyritic material. As the mill treatment has been improved lower-grade ores have been made available, but it is probable that the figures quoted from the Langlaagte and Crown Reef mines give the limit in this direction. It is true both these properties paid handsome dividends in 1893 but this was largely due to the 30,050 ounces and 29,679 ounces which they respectively obtained from old tailings.

The conclusion to be arrived at is an old one—"qui va piano va sano." South Africa will repeat the story of other mining districts, it will be an important gold producer, probably within a couple of years it will reach the first position (it has already surpassed Russia); but there is no reason to suppose that the phenomenal growth of its production will go on in arithmetical progression indefinitely, as many authorities would suggest. Its yield will serve to counterbalance the exhaustion of older regions but it will not have the economic importance of the early Californian and Australian discoveries. In 1851 California produced $81,294,700 after three years' development, in 1853 Australia yielded $62,001,761 after two years' development, in 1893 South Africa gave $28,272,407 after 6 years' vigorous and sys-

tematic work. It cost more to produce the 28 million dollars' worth of South African gold than it did to obtain the 143 millions yielded by California and Australia in the two years quoted. The explanation lies in the fact that South Africa has no large deposits of rich easily accessible alluvium.

The alluvium of the world is being rapidly removed, like the cream off a pot of milk. In the years between 1848 and 1875 no less than 87.78 per cent. of the gold of the world came, according to Professor Suess, from alluvium. I would estimate that in 1893 not more than 35 per cent. came from this source.

Those who talk enthusiastically of the activity in gold mining and of the enormous yield which is to come from that activity in the ten or twenty years that are to come should remember that Europe was once the great gold producing country of the world, that Dacia (now Transylvania) was a golden storehouse to the Romans ,and that in an earlier age Hannibal got the sinews of war from the gold mines of Spain. Where are they now? The former contribute a driblet, the latter are a tale in history.

Statisticians may sit at their desks and discourse entertainingly with the figures which are before them as a text; but the mining engineer who has been to the places where those figures are created knows full well that Ichabod is written over many a gold mining region which the statistician fondly imagines will continue indefinitely to add to the world's store of the yellow metal.

ADVANTAGES OF THE TEHUANTEPEC INTER-OCEANIC ROUTE.

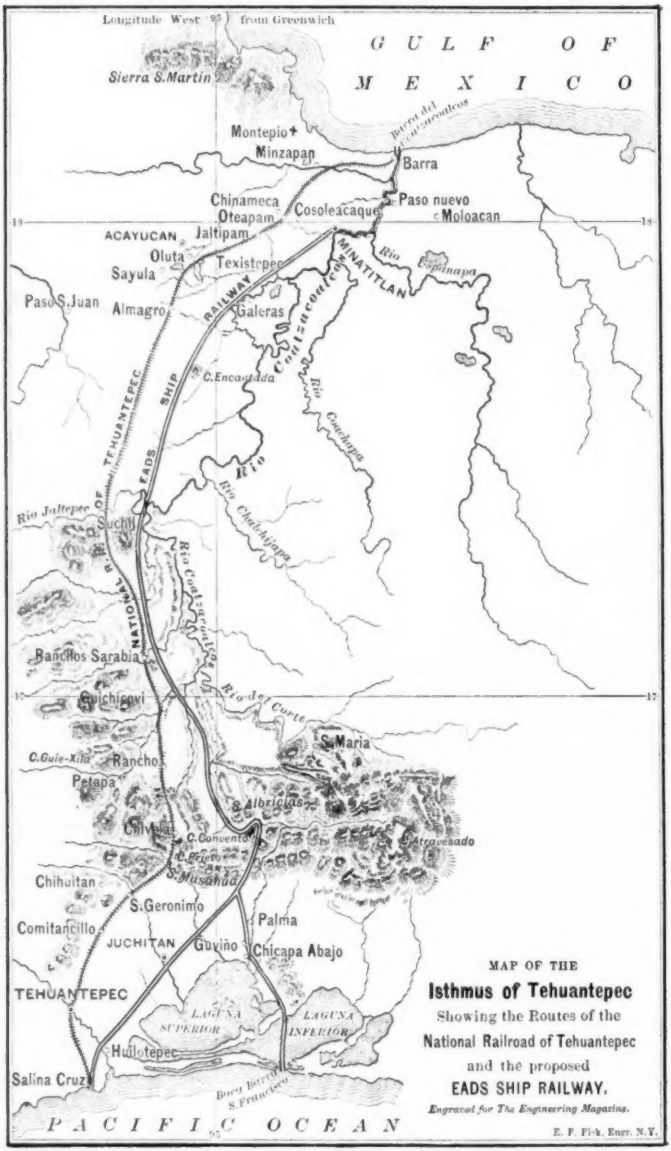
By Elmer L. Corthell.

FIFTEEN years ago, upon the sea end of the East jetty, extending into the Gulf of Mexico at the mouth of the Mississippi, the man who had conceived and successfully executed this great work stood one day watching the passing ships. The bar, on which there had been only eight feet of water, had, at his command, yielded to the current forces and had gone out into the depths of the gulf, through a splendid navigable channel, sufficient for the largest ocean-vessels. Turning from these ships and looking out across the gulf he saw in imagination a low-lying land, 800 miles distant, and beyond it the waters of the great Pacific. Awaking as from a reverie he said to the writer: "We must next discharge the commercial volume of the Mississippi into the Pacific ocean." Then eight years of Captain Eads's life were given to the stupendous task of conceiving and executing the plans for this work, and of convincing the civilized world that ships could be taken overland from ocean to ocean. On his death-bed almost his last words were, "I cannot die; I have not finished my work." But his project did not die with him; it is waiting for another great genius and the proper time.

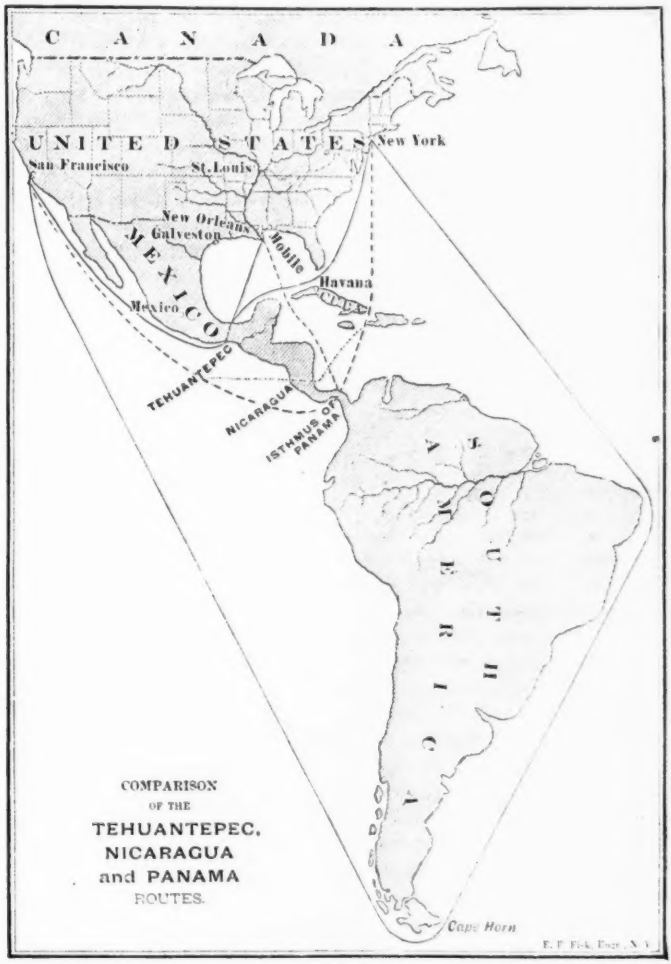
The other isthmian projects, which Captain Eads combatted and the failure of which he predicted, have come to grief already. It is not intended here to combat either of them, but simply to state the conditions, advantages, and entire feasibility of the Tehuantepec isthmus as a railway route, in the belief that the statement of the facts will be enough to prove the wisdom of President Diaz, of Mexico, in taxing the resources of his country to open here an interoceanic route.

Mr. Matias Romero, in the March number of this Magazine, has skillfully drawn the outlines and filled in one corner of the picture—that part which relates to the efforts since the time of Cortes to find a pathway at Tehuantepec for the commerce of the world. The present writer proposes to fill in the remaining details and endeavor to make the picture complete and in harmony with that strong and growing sentiment of this and other countries demanding the best possible method of interchange of the world's products, across the American isthmus, and particularly of connecting the eastern and western coasts of the United States via the isthmus.

The table of distances presented by Mr. Romero is so complete


Longitude West 95 from Greenwich
GULF OF MEXICO
Sierra S.Martin
Montepio
Minzapan
Barra
Chinameca
Oteapam
Cosoleacaque
Paso nuevo
Moloacan
ACAYUCAN
Jaltipam
Oluta
Texistepec
Sayula
Paso S.Juan
Almagro
RAILWAY
Galeras
Coatzacoalcos
MINATITLAN
Rio Tepetnapa
C.Encantada
SHIP
EADS
TEHUANTEPEC
OF
Rio Coatzacoalcos
Rio Chalchijapa
Rio Jaltepec
Suchil
NATIONAL
Rio Coatzacoalcos
Bancos Sarabia
Quichigovi
Rio del Corte
S.Maria
C.Guie-Xilla
Rancho
Petapa
Albricias
Chivela
C.Concento
Atravesado
S.Musahad
Chihuitan
S.Geronimo
Palma
Comitancillo
JUCHITAN
Guvino
Chicapa Abajo
TEHUANTEPEC
LAGUNA SUPERIOR
LAGUNA INFERIOR
Hulotepec
Salina Cruz
Boca Barra S.Francisco
PACIFIC OCEAN
MAP OF THE
Isthmus of Tehuantepec
Showing the Routes of the
National Railroad of Tehuantepec
and the proposed
EADS SHIP RAILWAY.
Engraved for The Engineering Magazine.
E. F. Fish, Engr. N.Y.

that the reader can by comparison see how much shorter is the Tehuantepec route as compared with other isthmian routes, but a study of the geographical features of this route, as well as of those around the southern extremity of South America, can best be made by means of an accompanying vignette map of the western hemisphere. By



noting the trend of shores and continents he will discover that all lines leading from any point on the Pacific coast of the American isthmus by the shortest route to those countries lying along what Mr. Romero calls the "axial line of the world's commerce," will pass directly in front of the harbor at Tehuantepec. The delusive maps which in our childhood taught us the shape of the earth and the relations of the countries to each other would lead us to suppose that the shortest line between San Francisco and Yokohama or Hongkong is a line apparently parallel to the equator, whereas the shortest line, by nearly 500 miles, is the one that passes across the Pacific nearly up to the Aleutian islands near Bering straits. The trend of the entire Mexican and Central American coast on the Pacific follows quite closely the shortest great circle between Panama and Asiatic ports, so that the Tehuantepec port on the Pacific has the advantage of the entire distance between it and Panama,—over 1200 miles,—saying nothing of the additional advantage on the Atlantic side by being much nearer to the ports of the Gulf of Mexico, the Atlantic coast of the United States, and western Europe. Supplementing Mr. Romero's table there is given below the *excess* distance of Panama over Tehuantepec in statute miles, in respect to some of the principal ports to be affected by an interoceanic route:

New York and Hongkong	1048 miles.
New York and Auckland	468 miles.
New York and Melbourne	403 miles.
New York and Honolulu	1139 miles.
New York and San Francisco	1182 miles.
Liverpool and San Francisco	797 miles.
New Orleans and San Francisco	1854 miles.
New Orleans and Auckland	1445 miles.
New Orleans and Honolulu	1980 miles.

The *physical* conditions on the isthmus would require an entire paper to state them. There are doubtless many persons living who, early in the "fifties," under the impulse of the gold fever which took so many to California, made the trip by way of Tehuantepec. A company was organized to build a very good carriage-road (except in the rainy season) through the wilderness and across the plains between the head of navigation on the Coatzacoalcos river and Ventosa, the harbor for the Gulf of Tehuantepec on the Pacific. The pleasantest part of the route was between the gulf and Suchil, about seventy-five miles, along the winding course of the great river Coatzacoalcos, which was navigated by the stern-wheel steamboat *Suchil*. This river for many miles is wide and deep, its banks covered with a luxuriant vegetation and many splendid varieties of forest trees. From Suchil for about thirty-five miles the traveled road at that time, and now the

path, lies through a grand and primeval forest, with boughs so thickly interlaced that for miles the sun, even at noonday, is shut out. Here are some of the most valuable woods in the world—the dark mahogany of beautiful grain, the white mahogany, the Spanish cedar, and many other fine woods The writer has often seen a half dozen large vessels at once loading at Minatitlan with mahogany and Spanish cedar for the United States and Europe. Only such of these woods as lie convenient to the navigable water-courses have been cut. Almost every kind of tropical fruit grows on the Atlantic slope of this isthmus, including bananas, plantains, oranges and lemons of the best varieties. There is no better country for coffee, tobacco, rice, and corn.

An interesting climatic feature is the sudden passing from the dense, exuberant vegetation of the Atlantic slope to the plains and the rolling pasture-lands of the Pacific. The climate, the soil, and the trees change entirely and almost instantly after passing the Jumuapa river. between the states of Vera Cruz and Oaxaca. From this point, towards the summit of the isthmus, the country is admirably adapted for grazing, and many great herds of cattle roam over these plains, everywhere so well watered by the mountain streams. After passing Chivela, which is at the head of a valley leading down to the Pacific, the Tehuantepec railroad now runs, through a cañon and the valley of the Verde to the Pacific plains, which for thirty miles are nearly level, with a sandy and clayey soil, with vegetation somewhat stunted, to the city of Tehuantepec on the left bank of the river of that name and thence for a few miles to Salina Cruz, the Pacific terminus of the railway. The rainfall on the isthmus is varied ; on the Pacific slope it is very light and on the Atlantic very heavy.

The accompanying general map of the isthmus shows the route of the projected ship-railway and that of the National railroad, the one starting from the mouth of the Coatzacoalcos river and the other from Minatitlan, about twenty miles up the river. These routes are not common except at one point, near Sarabia, where the railroad in its recent location goes through the pass found by the engineers of Captain Eads and since that time called the "Ship pass." Both have a common terminus at Salina Cruz, although it has been proposed to make a terminus for the ship-railway on the lower lagoon. The ship-railway route to Salina Cruz is 154 miles long, and that of the railroad 190 miles.

Perhaps at this time it will be of interest to describe the engineering features of the railroad, lately completed, in relation to which the efforts made by the Mexican government to furnish the necessary funds have been so fully outlined by Mr. Romero. A carefully written description is to be found in a paper by Mr. Manuel Rivera, C. E.,

one of the government inspectors on the railway. This paper was offered to the civil engineering division of the International Engineering Congress, at Chicago, but too late for presentation. Following is an abstract from this paper.

The line starts from the Bay of Salina Cruz, in the Gulf of Tehuantepec, on the Pacific, following the windings of a narrow ravine until it reaches the Zuleta pass, when it descends to Tehuantepec, a city of 15,000 inhabitants. Thence, in very easy lines, it passes across the Pacific plains to the foot of the ascent leading to the Chivela plains on the table-lands. Through the Chivela cañon the road is mostly built in solid rock. The lateral cañons, or ravines, are crossed by iron viaducts constructed by the Phenix Bridge Company, of Philadelphia. At Chivela the elevation is 790 feet above the sea-level, but there is a second summit to be overcome in crossing the Sierra de Niza Conejo (crazy rabbit), where the maximum summit is reached, 924 feet above sea-level. The maximum grade up to this point and in fact on the entire line is 2 per cent. and the curvature 200 meters (656 feet) radius, although in order to "join the rails" with as little loss of time as possible and with the least money there are temporary grades of 2 and even 3 per cent. and some few curves of 100 meters (328 feet) radius. The route across the table-lands lies through an ordinary rolling country, the maximum grade of the railroad being about 1.8 per cent. and maximum curvature about 600 feet radius. From the Jumuapa river the road passes through a dense forest for many miles to the Atlantic plains. The maximum grade on this slope is about 1.5 per cent. There are five large rivers to be bridged, the largest being the Jaltepec on the Atlantic slope, one of the chief tributaries of the Coatzacoalcos. The only tunnel on the line is about 300 feet in length. The material for the roadbed is generally good. The cross-ties and other timber were obtained from the United States, those for the Atlantic division coming from Pensacola or Mobile, and those for the Pacific slope from the red-wood forests of Oregon, but a large part of the iron-work was furnished by Great Britain. The rolling-stock is partly American and partly English. Sixty miles from the mouth of the Coatzacoalcos is found suitable limestone rock for harbor-works. At Coatzacoalcos there is a well-arranged and suitable terminal station and yard, the buildings for warehouses and shops being of iron, with corrugated roofs, manufactured in England.

There is no reason why, if some of the temporary sharp curves and grades are improved, which can be done at comparatively small expense, the road should not be operated economically and locomotives haul a train of twenty or twenty-five cars its entire length. The local business on the isthmus will be very considerable after the line is

opened, as the richness of the soil and the variety of the products will lead rapidly to the development of the country. Besides the railroad telegraph there is a first-class telegraph line on iron poles across the isthmus—a link in the important cable lines of the Mexican and South American Telegraph Company.

In order to make the railroad valuable as an interoceanic route it will be necessary to improve the two harbors. The terminus on the gulf is at the mouth of the Coatzacoalcos river, which carries to sea for several months of the year a large volume of fresh water. Its watershed is about 6500 square miles. The rainfall is quite regular, in its seasons and in its amount, so that it may be depended upon to give a sufficient velocity for excavating and maintaining a deep channel through the bar in the gulf at the mouth of the river. About five miles below Minatitlan, on the opposite side of the river, the largest tributary, the Uspanapa, discharges into the main river. Below the mouth of this tributary at a point in the straight reach of the river, where the width is about 1000 feet between banks, the average maximum depth on the sections is about 70 feet and the cross sectional area about 40,000 square feet. The magnitude of this river will be appreciated by a comparison of its area of cross-section with that of the South Pass, Mississippi river, which is 24,000 square feet. It may be said that there is inside of the headlands at the mouth of the river a continuous harbor at least ten miles long. In the area immediately at the mouth, and which will be used for harbor purposes, the 30-foot channel is about 1000 feet wide and the 40-foot channel 850 feet. The shore on the left bank of the river at the terminal is nearly straight for about a mile. The river enters the gulf between two headlands, one composed of sand dunes and the other of solid land about 60 feet high. The persistent fresh-water flow excavates a deep channel through the bar at the mouth of the river.

As to the sea forces available for maintenance, their magnitude and constancy may be appreciated by their action on the outer slope of the bar, preventing its advance, although there is poured into the sea by the river during the rainy season, an immense amount of sedimentary matter. This outer slope, if measured on the line of the proposed channel and between the 18-foot and 44-foot curves is about 1 in 100, which is a steeper slope than that of any of the other large rivers along the coast of the Gulf of Mexico, except that of the South Pass of the Mississippi as it existed before the jetties were built. These conditions are very favorable for economical construction and maintenance, since the combined action of the river and the sea, one behind and the other in front eroding the bar, greatly reduces the length of the works and the contents of the prism to be excavated by

the currents. The plans proposed contemplate parallel jetties extending 4500 feet from the shore to about 24 feet depth in the gulf; the distance between the jetties to be 800 feet. The material in the permanent structure will be entirely of rock. As this harbor is to be used for a great interoceanic traffic, where the largest class of vessels will enter, a channel less in depth than that at New York or New Orleans should not be considered.

As to the maintenance of these works it is believed that jetties, constructed on the plans adopted—based upon an examination made by the writer of the jetties at the mouth of the Maes, in Holland, where there is at times a much more severe exposure to waves than at any point on the Gulf of Mexico—will be able to withstand the waves from the northers, which blow with great force across the gulf from the Texas coast and are quite persistent during the winter. As the question of the existence of wind or littoral currents for maintenance of the channel and the erosion of the outer slope of the bar is such an important one it should be stated that there is a pronounced and constant sea-current with a velocity of from one to three miles per hour entering the Gulf of Mexico between the peninsula of Yucatan and the island of Cuba; this current hugs the shore line all the way along the concave shore of the main land, past the mouth of the Coatzacoalcos river, Vera Cruz, and Tampico.

An observation of the existing physical conditions justifies the belief that there will be a recession rather than an advance of the bar at Coatzacoalcos. There is now upon this bar about 14½ feet of water, and the depth is well maintained and has little variation. From surveys made by Captain Shufeldt, U. S. N. (1871), by the writer (1881), and by Mr. Ripley (1892), there is shown to have been no advance of this bar into the sea for twenty-one years past. The sea and river forces have been in equilibrium, and the bar has decreased in width about 400 feet. Inside of the harbor it is intended to build a wharf, of creosoted timber and piles or of steel, 2000 feet long, parallel to the shore. The slope of the bank into deep water is so steep that this wharf need not be more than 100 feet wide from the shore line into deep water. It is intended to equip this wharf with the necessary tracks, warehouses, and a complete hydraulic plant for handling freight quickly and economically from the ship to the cars and vice versa.

On the Pacific the harbor works will consist mainly of a breakwater of broken stone coped with concrete blocks. Here the coast forms a succession of beautiful curves, whose arcs range from two to eight miles in length. Between each pair of curves a rocky promontory extends into the ocean. On the west of the curve at Salina Cruz, about

three miles in length, the promontory is over 200 feet high and consists of hard durable rock, made up of quartzite, syenite, and porphyry. East of this promontory is a flat area of sandy formation with an elevation of about 15 feet above low water extending along the beach three miles to Ventosa. The sand of this formation is a coarse sharp grit of excellent quality for making concrete. The bottom of the bay seems to be of the same general character as the beach, no rock or clay having been found in the soundings. The slope of the shore under water is quite steep and deep water is therefore near at hand.

As the success of any improvement is largely dependent upon the action of the waves and currents it was gratifying to ascertain that the direction of the waves is almost normal, or at right angles, to the general direction of the coast, no matter from what direction the wind may blow, and that the current is always eastward along the shore. There is a constant surf upon the beach of sufficient magnitude to swamp any small boat except during the prevalence of one of the strong northers of winter, when but little surf exists. It will be necessary, therefore, to form a protected and quiet harbor. All freight must now be put ashore by small lighters, resulting in delay and in expense which is often as great as the entire freight-rate of sailing vessels between San Francisco and Liverpool around Cape Horn. To hope that vessels would lie at a pier in such a sea would be idle, and the expectation that any ordinary pier would stand such wave exposure would meet with early disappointment in the loss of the pier, even should the waves permit its construction.

It is estimated that the jetties and auxiliary works at Coatzacoalcos harbor will cost about $2,250,000, and the proposed terminal wharf and its equipment $360,000, the Salina Cruz breakwater $2,700,000, and the terminal piers and dredging $385,000, making a total for the harbors and terminals of $5,695,000 (gold). The contract for railroad work terminated in September. What it will cost to make the necessary betterments for interoceanic business in the way of reducing grades, improving curves, widening cuts, proper ballasting, equipment, and other expenses, it is difficult to estimate. Probably $2,000,000 would be sufficient to begin a good interoceanic traffic, so that the total estimated cost after September for the harbors and railroad, exclusive of interest during construction, would be about $8,000,000 in round numbers.

The commercial features give rise to questions that are of great moment and far-reaching. For fifteen years the writer has been chiefly interested, next to his engineering work, in the study of the relation of the American isthmus to interoceanic commerce. His investigation has been based upon the government statistics of commerce of the

United States, Great Britain, and other countries, reports of maritime and other exchanges, and the United States consular reports from every quarter, in order to learn what are the products and the imports of each country, and by which routes these are transported. Special study has been given to the development of the commerce of the Suez canal, which has revolutionized the commerce of the globe. All of this has been done in order to arrive at an estimate of the commerce which would fall to the Tehuantepec route when opened.

A special investigation has been made at my request by an acknowledged commercial expert—Mr. Thomas J. Vivian, in charge of transportation statistics of the United States census—who undertook the task of answering, in the shape of a report, nineteen far-reaching questions. The method and the scope of this inquiry and the valuable facts gathered, alone would make a magazine article of great interest. The inquiry embraced the whole world. Commercial movements are in such delicate equilibrium that a disturbance of any kind, an improvement of a route or the opening of a new one, may affect the entire commerce and, with it, the industries of the world. Take the tea trade, for which the Suez canal and the transcontinental lines of the United States are contending. In 1884 49,964,482 pounds of tea reached the Atlantic coast of the United States from China via the Indian ocean, the Suez canal, the Mediterranean, and the Atlantic, while 18,256,764 pounds came across the Pacific, via the transcontinental lines to the country east of the Missouri river. But the San Francisco route is gaining. In 1890 the amount of tea received via Suez had decreased to 43,000,000 pounds, although the total amount handled had increased enormously. At the same time the amount handled by rail had increased to 39,000,000 pounds. It is necessary, therefore, to study the increase, as well as the general movements on the various routes of the entire traffic of the world.

The aggregate commerce of the five principal maritime nations—the United States, Great Britain, Germany, France, and Spain—increased 20 per cent. in the last decade, the annual increase averaging 2 per cent. Probably this rate would be diminished by including the returns from all other nations. It is safe to estimate the annual increase of the commerce of the whole world during the present decade at $1\frac{1}{10}$ per cent., at least, and this figure is used in the estimates which follow. From the sources mentioned tables have been compiled showing the number and registered tonnage of vessels engaged in trade between the ports of twelve countries and the ports of twenty distinct countries on the Pacific and Indian oceans in 1890. Other tables show the commerce on still other routes. Analyses have been made of the amount of freight constituting the transcontinental traffic

between the Pacific and points east of the Missouri river, with details of the freight carried from seaboard to seaboard; even the passenger traffic has been carefully investigated, that transported on certain routes in 1891 being compared with estimates of the percentage and number that would travel in 1896 via the Tehuantepec route, between Australia, Honolulu, China, and Japan to Europe, Pacific, Mexican and Central American ports to Europe, San Francisco to New York via Panama and vice versa, the westward movements, and other, though perhaps less important, travel between Cuba and China via New Orleans; passengers via the Suez canal and local passengers from all points on the western coast of Central and South America to points east of the isthmus on the Gulf and Atlantic. The time required for freight by various routes and the estimated time via Tehuantepec has been carefully investigated.

As an illustration of the importance of this examination take the following summary as between the representative terminii of New York and San Francisco, in which is given the actual time consumed in days and the distance in statute miles, equating the ocean and rail distance by multiplying the latter by 3; although if the equation is made on the basis of the real comparative cost 5 rather than 3 should be used.

ROUTES.	Number of Days.	Miles.
Around Cape Horn (by sail)	140	15,420
Via Straits Magellan (steam)	60	13,090
Via Transcontinental lines (fast freight)	25	10,203
Southern Pacific to New Orleans (rail). New Orleans to New York (steamship, fast freight)	14	9,386
Via Tehuantepec	20	4,280

One of the most important reasons for opening the Tehuantepec route will be seen by comparing the time and distance of the all-rail routes with the time and distance of the half-rail and half-ocean routes by way of New Orleans. In these simple figures lie the main reasons why the Southern Pacific and Morgan line route via New Orleans has been able to obtain from 75 to 90 per cent. of our entire transcontinental traffic. Now, if the fact that this route is one-half water has given it such an immense advantage over the all-rail lines, may we not expect that, by carrying this principle further and uniting the two coasts by a practically all-water route on the shortest possible line, we may obtain some of the immense traffic between the Atlantic and Pacific coasts and interior of the United States? May we not further

expect from the new and extraordinary facilities given to this country and particularly to the ports of the Gulf of Mexico we may develop an entirely new coastwise traffic between the southern and eastern coasts of the United States and Mexico and the Pacific?

Freight rates by all the various routes and of different classes of freight have been studied for the purpose of determining a reasonable charge for transportation via Tehuantepec. The highest and lowest freight-rates in 1891 on the eastern and western routes of the world for representative cargoes have been followed in great detail for the purpose of forming a reliable judgment. The varied questions of the present increase of traffic on all the main routes between the various countries and for various products have been investigated and these results applied to the proposed route at Tehuantepec. The estimate of the commerce that will be handled by the National Railroad of Tehuantepec has been based upon (1) the annual increase of the world's commerce, (2) the traffic of the season of 1890-91, and (3) the time fixed for opening up the route (1896). The traffic figures are based on freight tonnage, the rates being on the basis of the weight of commodities and not the registered tonnage of vessels. Instead of quoting a meridian of longitude as the boundary of the "attractive influence" of the Tehuantepec route, the actual reports of shippers and recognized facts, and the trend of commerce, have been taken to show the extent of this influence. It has been properly considered in the estimate that the saving in distance and time by the Tehuantepec route means that by a shorter route a larger number of voyages per annum can be made and consequently greater return to the vessel-owners on their investments and, in addition to this saving, an increase of annual earning capacity of vessels. By the use of the shorter route there would be the saving in the wear and tear of craft by avoiding the stormy routes by Cape of Good Hope and Cape Horn, also smaller cost of insurance and a general diminution of running expenses. It has also been taken into consideration that sailing-vessels could use this route, while it is impracticable for them to use the Suez canal on account of the impossibility of navigating the Red sea, or to use the Panama route on account of unfavorable nautical conditions in both oceans.

The writer contends that the great advantages—geographical, physical, nautical and commercial—of the Tehuantepec route over Cape of Good Hope, Suez canal, Cape Horn, Straits of Magellan, Panama, Nicaragua and the transcontinental lines would enable it to divert to itself and create a combined aggregate tonnage of great magnitude, and that this route can successfully compete with any of those above mentioned, including Nicaragua, which is considered

(erroneously in the opinion of the writer) to possess great special advantages. But the writer also knows that the Tehuantepec route must, in order to compete successfully, be fully equipped in extensive terminal and wharf facilities and be operated on the lowest possible grades permissible, with the easiest curvature, with a sufficient equipment of rolling-stock and in close connection with its own steamship line on the Pacific and the Atlantic, with harbors on both sides accessible to the largest ocean vessels under all conditions of weather.

On the above basis a summary of the detailed estimate shows that there may be reasonably expected in 1896 a total through traffic of 5,288,037 tons and that the gross receipts, with the addition of the passenger business and the local traffic on the isthmus from the adjacent and already rapidly-developing country, would amount to over $10,000,000 (gold).

The importance to the United States and to all other maritime nations to provide an interoceanic route, the approaches to which are favorable for sailing vessels, cannot be overestimated. Mr. Romero has given a brief comparison of nautical conditions at various points on the American isthmus which shows the impracticability of sailing vessels using the more southern routes on account of persistent calms and unfavorable winds in both oceans, and the entire practicability at Tehuantepec, on account of favorable winds. The world's tonnage that will be affected by an interoceanic route is larger in sail than in steam. In the fiscal year 1892–93 the fleet employed in trade between European and United States Atlantic ports and between Australasia and the Pacific coast was made up as follows:

	Steam.	Sail.
Register tonnage	2,535,202	3,958,891
Equal to cargo tonnage	3,250,000	6,400,000

In conclusion it should be stated that, by the wisdom and far-seeing policy and the persistent efforts of the president of the Mexican republic, not only the railroad, but the harbors, terminal facilities, and sufficient equipment, and all that is above outlined will be provided within the next three years. The opening of this interoceanic route for the benefit not only of Mexico but of the world is one of President Diaz's cherished objects. The question now is into whose hands will this important route fall for operation and control. Shall it pass to Europeans or to citizens of the United States? The country the citizens of which shall operate it will have for the next century a commercial advantage that cannot be overestimated. By whomsoever operated, this route is certain to effect a revolution more far-reaching and more important to the commerce and industry of the world than that which followed the construction of the Suez canal.

DOMESTIC ELECTRIC LIGHTING PLANTS.

By Nelson W. Perry, E. M.

SOME one has said that civilization is a device of the devil for increasing our wants instead of satisfying them. Certain it is that the luxuries of yesterday are the necessities of to-day, and nowhere has this been made more manifest than in the conveniences that have been provided by the advances in electrical science during the past two decades. But if the advance in science has done naught but to stimulate our desires, it has fallen far short of its province; nor will our experience bear out such a statement. There is an old saying that there is an innate tendency in the human makeup to revert back to the savage state; but who that has once availed himself of the facilities of the telegraph and the telephone, by which distances are annihilated would now magnify those distances by the methods of long ago? Who that has enjoyed the humane and rapid methods of urban electric transit would willingly return to the plodding car horse or mule? Who that has accustomed himself to the brilliant and healthful illumination by the electric arc and incandescent filament would exchange them for the tallow dip or the rushlight of our fathers? All these things have now become a part—a necessary part of our metropolitan civilization. And yet even more. The telegraph and the telephone have long since overstepped all mural bounds and the electric railroad is fast invading the precincts of the turnpike, the county road, and even the territory of the steam locomotive. The electric light, however, has thus far, in this country, remained only for those living in communities of sufficient size to make the distribution of electric current in large quantities profitable to companies organized for the purpose. To many of these, too, the electric current, on account of its greater cost than gas, still remains a luxury; but with those of means, especially the business man, it has already taken its place among the necessities of the times to such an extent that no business building is now considered modern in its equipment that is not supplied throughout with the electric light.

Whatever may be said of the conservatism of England and of Germany that has prevented them from ranking with the United States in the adoption of modern innovations, those two countries have far outstripped us in the solution of the problem of cheap domestic electric lighting, and we must learn of them, as at Gamaliel's feet, the lessons they have already learned and have proved so well.

It is from these two countries that we have learned what at first

appears so anomalous, viz.: that more light can be obtained by using gas in a gas engine driving a dynamo than can be obtained by burning that same gas direct in the best gas burner. There are few who will accept this statement without corroborative proof, and it is the purpose of this article to supply that proof by figures taken from actual practice within the experience of the author. It may be well, however, to introduce such demonstration by indicating how, on theoretical grounds, such a showing is well within the bounds of possibility, and then to follow it up by showing how well the actual results conform to those we are led to expect from mere theory.

Prof. Tyndall gives the average luminous radiations from a gas flame as only $\frac{317}{1000}$ per cent. of the total radiations. The production of light by burning gas is therefore one of the most uneconomical transformations of energy that man is accustomed to employ.

The incandescent electric lamp, however, has a much greater light efficiency than the gas flame. A 3.5 watt lamp, viz., one consuming 3.5 watts per candle power has a light efficiency of 6 per cent. or 18.8 times that of the gas flame. The gas engine not infrequently has a thermal efficiency of 20 per cent., and a mechanical efficiency of 85 per cent.; the dynamo efficiency may be taken at 95 per cent. and the light efficiency of the incandescent lamp being as above equal to 6 per cent. we will have a final efficiency after these several transformations of $20\% \times 85\% \times 95\% \times 6\% = \frac{969}{10000}$ of 1%.

But in practice there are some other losses than those taken account of above. The dynamo is usually belted to the engine, involving a loss approximating 10 per cent. There is also a loss in transmission of the current from the dynamo to the lamps. For present purposes this may be placed at 5 per cent. Assuming an efficiency of our dynamo of 95 per cent. we may call the combined efficiency of dynamo and belt and electrical transmission 80 per cent. The efficiency of the various transformations from the gas to the electric light becomes therefore $20\% \times 80\% \times 85\% \times 6\% = \frac{816}{10000}$ per cent. as against $\frac{317}{10000}$ per cent. for gas direct or a ratio of 2.57 to 1. This is to say that for every candle power produced in consuming gas in a burner direct there can be produced through the intermediary of the gas engine, dynamo and incandescent lamp 2.57 candle power from the same gas.

As indicating the extent to which gas engines are used abroad, Mr. F. H. Mason, the United States consul to Germany, in a report to our government last spring stated that at that time the number of gas motors in use in Germany in all the smaller forms of manufacture where the motive power required did not exceed 75 to 150 horse-power, amounted to 18,000, aggregating 60,000 horse-power; and estimates that through the cheapening of gas the rapid extension of electric

lighting and other applications of electricity the use of gas engines has been very largely increased since then. In evidence of this, he states that the two principal makers of gas engines in Germany have alone made and delivered during the past two years 1950 such motors, and estimates that the number in actual service in Germany cannot now be far short of 24,000 to 25,000.

An English estimate places the total number of gas engines in use in England at about 40,000, of which, according to Mr. Dowson, about 12½ per cent. are employed for electric generation. There are no figures at hand for the number of gas engines in use in this country, but while it is undoubtedly much less than in either Germany or England, it is still quite large, though the percentage used to drive electrical machinery is as yet quite insignificant. The extent to which they are used both here and abroad is sufficient however to show that they have passed the experimental stages, and have already become important factors in all questions in which prime movers are concerned.

Thus far we have arrived at the economy of the gas engine from theoretical deductions. That conclusions thus reached will not be satisfactory I am well aware, and my paper would be incomplete were not well authenticated data brought to substantiate these claims.

Leaving out of consideration data of actual working abroad, for the reason that some of the conditions there and here are so different as to render them of little value for purposes of comparison, we come to the somewhat limited practice in this country. In the first place, the makers of gas engines here will guarantee the production of an actual horse-power for 1 hour by the consumption of from 17 to 20 cubic feet of gas, or a pint of gasoline. This is somewhat better than is usually guaranteed by European makers, but such figures must be considered always as mere approximations, and as somewhat indefinite unless the quality of the gas or gasoline be also specified. In general whatever is said here in regard to gas engines applies equally to gasoline engines, with the reservation that gasoline is somewhat more economical fuel than gas.

As showing the reasonableness of the figures claimed by the gas engine manufacturers, and also of those used in this paper in the calculations presented, I append the results of a very careful series of tests made by Messrs. W. F. Hunt and W. J. Andrews, of Cornell University.

Engine No. 1 was a 12 horse-power nominal, and engine No. 2 a 6 horse-power nominal with dimensions as follows:

	No. 1.	No. 2.
Diameter of piston	6.75″	5.75″
Length of stroke	1.2916 ft.	1.041 ft.
Clearance, % vol.	34.95	25.63

No. of Engine.	No. of Test.	R. P. M.	Explosions per Min.	I. H. P.	D. H. P.	Cu. ft. Gas. per I. H. P.	Cu. ft. Gas. per D. H. P.	B. T. U. per I. H. P.	Mechanical Effic.	Thermal Efficiency.	Cost per D. H. P.	Cost pr. E. H. P. 15% Loss	Cost per Lamp-hour @ 12 Lamps per H. P.
1	1	245	73	9.	7.03	18.125	23.2	12358	.781	.295	3.48	4.09	0.34
1	2	246	120	15.35	12.9	17.825	20.43	12150	.842	.289	3.06	3.6	0.3
2	3	395	143	9.38	8.38	19.78	22.14	13460	.893	.187	3.32	3.9	0.33
2	4	265	123	8.50	7.66	18.4	20.42	12460	.901	.204	3.063	3.6	0.3
2	5	312	153	10.12	9.08	19.235	21.416	13040	.897	.1951	3.22	3.79	0.32
2	6	393	15.2	1.03	0	18.39	.....	12350	.....	.206	.....	.....	.....
2	7	397	78.2	5.31	4.28	19.59	24.68	13410	.807	.2895	3.70	4.35	0.36
2	8	394	80.8	5.98	4.83	18.525	22.05	12555	.808	.2025	3.44	4.04	0.34

The last three columns I have calculated myself from the data given by Hunt and Andrews assuming the cost of gas used to be $1.50 per 1000 cubic feet.

It will be seen from this table that the cost per lamp-hour (one 16 candle-power lamp for one hour) reaches a minimum of $\frac{3}{10}$ of a cent in both engines when fully loaded, and $\frac{3.4}{100}$ and $\frac{3.6}{100}$ of a cent respectively for numbers 1 and 2 when running under light load. On the other hand, on the assumption that it requires 5 cubic feet of gas to produce the same amount of light for the same time, the cost would be $\frac{5.5}{100}$ of a cent.

It also becomes apparent that if the gas engine can be relied upon to do its work properly with the attendance that can be given it by ordinary domestic help, it furnishes a happy solution of the question of cheap electric lighting not only for city residences but also for suburban and country homes. To settle this latter question, the writer has corresponded with a large number of owners of private lighting plants operated by gas and gasoline engines, as to their experience with them. Nearly all of the replies received were of a favorable nature as far as they went, but there are few who have ever kept a sufficiently close tally upon the operation of their plants to enable them to give specific information in regard to the economies attained.

Their letters received are, however, instructive, and of sufficient interest to warrant their reproduction in part here.

Messrs. Wm. S. Sons & Co., Dry Goods Commission Merchants, Philadelphia, Pa., write that they have a 6 horse-power gas engine operating a 2½ k. w. (3⅓ horse-power) dynamo, which they introduced "simply for comfort and convenience" and that the "cost of running and repairs has not been considered by them." However, they give the following data in response to my inquiries. The daily use of the plant varies from 12 hours to nothing. The average number of lamps

at one time is given as 25, and the average use per day as about 4 hours. Their gas bills for engine show a consumption of 150,400 cubic feet of gas in 299 working days or an average of 503 cubic feet daily. Gas costs $1 per 1000 cubic feet, making the cost 50 3/10 cents per day, or a little over ¼ cent per lamp per hour.

The plant has been in operation nearly four years and originally cost complete $1400. The lamps are steady and entirely satisfactory. Engine attended to by porter in store. Cost for repairs stated to be not over $20 per annum, including lamp renewals.

Messrs. W. Bros., Manufacturers of Pianos, New York city, reply that they have a 15 horse-power gas engine, operating a dynamo of from 12 to 13 horse-power. The maximum number of lamps wired is 150; the maximum number ever used at one time is 140, and these vary from 2 to 6 hours per day. They write that "We used gas for lighting before we had the electric plant. The electric plant is a great deal the cheaper." This plant has been in operation nearly three years, and they state that it has cost them scarcely anything for repairs. The lights are very steady when the engine is working nearly up to full load, but show some unsteadiness when the load is light. The engine cost about $1700 and the electric plant, put in complete, cost $1650.

Messrs. B. Bros., Bronze Statuary and Founders, Philadelphia, write that in 1891 they put in a 9 horse-power gas engine at a cost of $900 and a 90-light dynamo at a cost of $380, including all wiring, 4 arc and 25 incandescent lamps, "We have at the present time," they say, "4 arc lamps and about 25 incandescent lamps in when lit up, and generally use them from 4.30 to 6.30 P. M.; and for the last three weeks have been using 2 arc and 15 incandescent lamps from 6 to 9 P. M. After starting up we do not have to give engine or dynamo any attention whatever until stopping time. The engine uses about ¼ of a gallon—a little under—of gasoline of 75° per horse-power per hour, at 9 cents per gallon, which makes pretty cheap lighting. The lights are slightly unsteady at each discharge of the engine, which can be overcome, however, by using a fly-wheel on the engine. We do not find this unsteadiness in the least annoying, as we can read and write very well with it. We also do our very fine molding with it, which was very trying under the old way of using gas light, and our men would not go back to gas. . . The engine after it is oiled and started up does not require any attention. Neither the engine or dynamo have cost us anything for repairs from the time of placing them in our works. . . We think that it is the best and cheapest lighting that can be had. The only objection is the first great cost for installing the plant in a house or shop. Anybody, once shown how to start the engine, can run it."

Mr. Jos. I. K., Importer and Commission Merchant, Philadelphia, is employing a gas engine to run his elevator and about 25 incandescent lamps. He writes that his plant has been in operation for nearly six years. His light, he says, is cheaper and better than gas, and the repairs to the entire plant have averaged less than $20 per annum. In conclusion, he says "my experience in the matter in connection with which I forward the above replies has been perfectly satisfactory in every way."

The above are fair samples of many answers received: but, as before stated, they are more general than specific. In order that I might have more accurate data at hand, I have personally examined and tested a number of lighting plants, one of which I will describe briefly as typical of one of the two systems of lighting now in vogue with gas engines as prime motors. This is the private plant at the residence of Mr. G. Morosini, at Riverdale, on the Hudson.

This plant is noteworthy as being probably the largest and most complete private lighting plant of the kind in the country. It consists of two White & Middleton gasoline engines belted each to a 10 horse-power Perret generator. These latter are connected with a switch-board which is also double, so that either dynamo may be separately connected with the house circuits or with the storage battery: or they may be connected together in parallel with either the house circuits or the battery. The storage battery consists of two series of Consolidated Electric Storage Battery cells, each of 60 cells, which when connected in parallel, have a normal discharge rate of 70 amperes. This plant is installed in a small brick building some distance from the house. Except on special occasions when the full capacity of the plant is required, the lighting is done entirely from the storage battery: but on these special occasions both the battery and the dynamo are put into service. In charging the battery but one dynamo is used, and this is run so as to give a current of 73 amperes at from 125 to 150 volts. The charging of the battery occupies two or three hours per day, during which time only is the machinery usually in operation.

When the dynamo is charging the batteries at the rate of 63 amperes and 145 volts the engine consumes 4 gallons of gasoline per hour. Estimating the cost of gasoline when bought by the barrel at 8½ cents per gallon makes the engine and dynamo cost for this service equal 36 cents per hour. Let us assume for the sake of a margin, however, that the oil costs 10 cents per gallon, the cost per hour for fuel in charging the storage battery will be 40 cents. 63 amperes at 145 volts=9135 watts=12.2 horse power, cost 40 cents=3.28 cents per horse power per hour. If this current were delivered directly to the lamps through the mains, allowing 10 per cent. loss in transmis-

sion there would be an effective E. M. F. at the lamp terminals of $145-14.5=130.5$ volts. If the lamps be 110 volt lamps and their resistance 220 ohms, they will each take $\frac{1}{2}\frac{1}{2}\frac{0}{0}=.59$ amperes of current, say 0.6 amperes. If each lamp takes 0.6 amperes and there are 59 amperes available, the 4 gallons of oil will supply $\frac{5}{0.6}\frac{6}{0}=93$ lamps at a cost of 40 cents, or at the rate of $\frac{4}{9}\frac{0}{3}=0.43$ cents per lamp per hour. This corresponds very closely with the figures arrived at from theoretical considerations. But the current from this plant is not usually used in the lamps direct, but for charging the storage battery. By this latter recourse much better service is obtained in that the current is available at all times independent of the engine, and the lights are absolutely steady. These greater conveniences are obtained, however, at a much greater cost both in original outlay and in running expenses. As to original outlay for plant about 100 per cent. must be added for storage battery and in operating expenses about 20 per cent. Allowing for the latter, the figures for operating cost must be increased from 0.43 cent per lamp hour to about 10.54 cents. Mr. Morosini also employs an electrician to attend to his plant who devotes about 3 hours per day to this service, the cost of which must also be charged against the lamps. This additional charge, as well as those for interest on the investment, depreciation, etc., will be practically constant whether many or few lamps are burning for a greater or less length of time. It will of course be much less with a large number of lamps than with a few and less in winter because of the greater number of lamp hours than in summer. As a matter of fact Mr. Morosini's residence is wired for 400 lamps and the consumption of current averages in summer 200 ampere hours and in winter about 400 ampere hours per night—respectively equivalent to about 400 and 800 lamp hours, which means an additional charge on account of attendance of about ½ and ¼ cents per lamp per hour. This will bring the cost of lights up to 1 cent an hour in summer and ¾ cents per hour in winter. Comparing this with the cost of electric lighting as furnished from the central station we find it is about the same in summer and a little cheaper in winter, the charges for central station service being universally 1 cent per lamp hour. With gas at $1.50 per 1000 cubic feet, assuming 5 cubic feet of gas to give an equivalent to 16 candles, the cost would be ¾ cent per lamp hour or the same as the electric light costs Mr. Morisini in winter time under the above assumptions. On the other hand, another gas plant, using gas without the storage battery, supplied 56 lamps (which was about half load for the engine) with a consumption of .160 cubic feet of gas or at a cost of $\frac{4}{1}\frac{3}{0}\frac{.}{0}$ cent per lamp per hour. These lamps, operated at about 115 volts pressure, considerably exceeded their rated power of 16 candles each.

The noise of the gas engine is its greatest objection for domestic uses, but this has been greatly reduced by connecting the exhaust pipe with underground or otherwise muffled chambers.

If storage batteries be used, the generating plant may be materially reduced in size. Undoubtedly one third of the power required for direct lighting would be sufficient under these circumstances on account of the short hours of service required in private residences. As a further offset to the additional expense of the storage battery the engines may, when working, operate at their maximum load, and therefore under far more economical conditions than usually met with when they supply current direct to the lamps. Prof. Kennedy is responsible for the statement that the consumption of gas per horse power in a gas engine at half load is 40 per cent. more than that required at full load. Assuming this to be true the loss of 20 per cent. which we have allowed in the storage battery is considerably more than counterbalanced by the increased efficiency of the engine.

The storage battery more than doubles the cost of installation except in very small plants where the increase is slightly less than 100 per cent. For this reason many will prefer the plant without the storage battery. They will, however, have to put up with the inconvenience of running the engine as long as the light is required at night and doing without light from this time until the engine is started up again. In many cases this will not prove an inconvenience.

One of the greatest drawbacks to the more general introduction of lighting plants such as here advocated has been the absence of any one who would guarantee the performance of the plant as a whole. Heretofore one company has put in the engine, another the dynamo and a third the storage battery, etc. The investor has therefore been compelled to assume the risk and responsibility which has in some cases proved irksome. The average investor, too, seldom has the time to investigate the merits of the various parts that go to make up the plant and still less often is he qualified to discriminate between what is bad and what is really good. What is required is a firm or company that will assume all these obligations, that will contract to erect a plant complete for a certain price on a guarantee of performance without the fulfillment of which they will hold the investor safe, and without expense for the experiment. There would seem to be an immense field for the proper parties in this direction. The only astonishing thing about it being that it has remained so long unoccupied.

EDITORIAL

Municipal Engineering and Politics.

ONE of the most notable specimens of engineering construction ever carried out in the United States by the funds of a municipality, is that described and illustrated in the interesting article contributed to the present number of this Magazine by Mr. Frank E. Snyder, C. E. The great dam at Austin is exceptional in American engineering on three distinct lines. It is perhaps the first attempt of a municipality to engage in the business of power supply to shops and factories, and, as such, it is extremely interesting as an initial experiment in a new line of municipal ownership. It is interesting also as an engineering work *per se*. It is further of interest as a specimen of municipal engineering construction which has escaped serious defects usually forced upon municipal contract work through concessions to political rings or to incompetent officials whose offices are due to political influence, and who, while they may be adepts in politics know very little or nothing of engineering problems.

Considered as an experiment in municipal ownership, there will be, of course, two entirely opposite views as to the wisdom of such undertakings on the part of city governments. By some it will be deemed directly in the line of human progress—a step toward the parental government which many are urging as a great scheme for ameliorating special ills now burdening society. On the other hand, there is a school of able thinkers who believe these ills to be temporary—the nominal result of a transition stage, and that they will disappear when the framework of society has adjusted itself to new conditions; just as the walls of a building cease to crack after the foundations have settled to a rigid basis. These economists believe that parental government would simply entail greater evils than those now existing which all would gladly join in removing could the unmistakable way for their removal be clearly pointed out.

Progress in municipal engineering has been obstructed in two ways. The first is, that engineers who have much to do with city contracts are, as a rule, compelled also to be political wire-pullers; or, if not that, to get a pull with the wire-pullers by dividing profits with the latter in order to obtain the contracts. Few men have ever succeeded in combining two callings and taking front rank in either. It is hard to conceive of anything more opposed to the thorough, consecutive, calm consideration of engineering problems necessary to their successful solution, than a political scramble, or anything more obstructive to good engineering work than the concessions to political hucksters that contractors are obliged to make in the execution of important city work, such as the enforced employment of incompetent assistants, or the purchase of inferior materials from men who are in the ring and who will prove obstructive unless their demands are met, with all the other "ways that are dark" of the modern city politician.

The fact is, that too many things needed for the supply of the necessities of urban life are now controlled by gangs of political robbers; yet they would be rejoiced to get more. Municipal ownership of gas works, of street railways, of rapid transit lines, of electric lighting plants, simply means more opportunities, more places for ward heelers; in a word, more robbery from the public purse. There cannot be too much municipal ownership to suit rings. The fatness of street cleaning contracts, of jobs in paving streets, of care of public buildings and property, of docks and parks, of police and fire departments have not and cannot satisfy a greed which is insatiable; and if the control of fuel and food supply, and all the other necessaries

of life were offered to this political Moloch of modern municipal rule, its cavernous mouth would open like an alligator's to gulp it in. In the light which has lately been shed upon the true inwardness of municipal rule, it is difficult to conceive how any man, educated, intelligent and sane, can, with a good conscience advocate any extension of municipal ownership. The history of public works in American cities is blotted all along the line with fraud, blackmail and other forms of extortion. It is only a short time since a large contract for constructing a street railway was abandoned in the city of New York by a firm in Philadelphia, after much work had been done upon it. The reason assigned by the Philadelphia firm was that the New York city officials so obstructed the progress of the work (one of their favorite contractors having been underbid in the letting of the contract) that there was no possibility of finishing the work in the time specified; and the Philadelphia firm preferred to lose the large sum they had already expended, rather than make any further attempts to struggle against the obstacles constantly so interposed, and thus to risk further losses. Whether this statement could have been substantiated by evidence or not, no one who knows how things have been managed in New York for many years would consider it at all improbable.

The extension of municipal ownership will increase the burdens of any city that indulges in such folly. Affairs may run smoothly enough for a time, but when the harvest gets ripe the rings will surely reap it.

Architectural Criticism.

ARCHITECTURAL criticism must be good or bad. Some very bad examples have lately been referred to in these pages, and further examples, as must necessarily come to light from time to time, will be commented upon in due course. That most of what passes as architectural criticism is bad doubtless no architect will hesitate to affirm. And in this the architects are generally right. Mere wordiness is no proof of critical ability, and it would seem to be the first requisite of every writer on architecture that he first equip himself with at least an elementary knowledge of what architecture is and how it is practiced, and learn the position of architects towards their art. Just criticism is almost impossible unless a writer will limit himself to certain phases of the art with which he can make himself familiar. The manifold conditions under which architecture is now practised throughout the civilized world render it almost impossible to judge buildings by referring them to some ideal standard that can never be reached in actual practice. The critic is not the only one who suffers from this, for it is the most vexatious thing the architect himself has to consider. Unless, therefore, the critic can bring himself to a modern atmosphere and learn to know and to realize the limiting conditions under which all architects are forced to work, it would be better that he never opened his mouth at all, be his language ever so refined. The question of language has really a great deal to do with it, since very many people imagine that skill in setting forth signs of ideas—that is to say, words—is the foundation on which the critic rests. This is generally the fact, but it is utterly wrong. It's much easier to take buildings to pieces than to design and construct them, and it is this which gives the critic his hold upon the popular fancy and makes his essays attractive to the average magazine editor. Of the reams of architectural articles that have been published in the last five years there has not been one, if our memory serves us aright, that deals with the actual conditions of modern architecture. Professor A. D. F. Hamlin did, it is true, write most lucidly and sympathetically on this very point in the *Architectural Record* some years ago, but his articles reached a professional audience rather than a popular one. But with this exception we have had nothing but comments, ravings, praises, condemnations,—varying according to the temperament of the writer and his sympathy with the subject he is attempting to elucidate. And as it is easy to praise, if one be a faddist, or

to condemn, if one be a censurist, most of the architectural writings in the popular press have been of either of these descriptions.

Architectural writers may be severe in treating of architects, but it would be an even wager that architects could excel them if they would take the opportunity to speak aloud the impressions they keep to themselves. Each architect is the best architect in the world. If he is not better than the next fellow he has little excuse for practising his profession. And unless he has a full appreciation of the strong points in his work he cannot expect others to have it. But what architect who has taken part in a competition for a building, unless he is a very young man who goes into it more for the reputation it may bring him, is ever satisfied with the result if he is not successful? The most he will do is to admit that his design would have been as good as the accepted one. And then he will imagine all sorts of impossible reasons why the other should have been taken and he left. What architect ever visited an architectural exhibition who did not know that his designs, which he cannot see anywhere, were infinitely better than 99 per cent. of those hung? So it goes. And if these gentlemen were to take the trouble to write down their deliberate judgment of their brothers in architecture, the poor critic, with all the dictionaries in the world, would make a very slight showing. Wholesale condemnation of the critic is, therefore, as unwise as the latter's wholesale condemnation of architects. Both sin alike in their own way. Each is alive to the mote in the other's eye, while blind to the beam in his own. Yet should the architect, who is so ready to condemn brother architects, find fault with the critic for doing exactly the same thing he does, especially when he does it in a milder manner and with a greater assumption of justice? The architect's ideal of criticism is not sharp words but gentle praises. He knows the evil of indiscriminate praise and does not look for it, but when he has put weeks of thought into a work, done his very best and striven to surpass himself and his contemporaries, he cannot see why a man (or woman) who knows nothing of the mental state he has been in should condemn him off-hand. The position has some reason in it, but it is not wholly reasonable. So much of what passes as architectural criticism is so light and unimportant that the wisest course is to consider the source and disregard it. B. F.

The Hudson River Bridge.

SINCE the report of the board of experts to the War Department was issued some time ago, expressions of opinion on the report have been advanced from almost every engineering authority; and these opinions, while recognizing the spirit of fairness and conservatism of the board in making its estimates and drawing its conclusions, are for the most part in dissent.

As in every similar large project, there are two main questions to be considered—the engineering feasibility and the commercial profit. Further, ideals of safety and efficiency must always be modified by considerations of expediency, so that no structure is quite up to the mark aimed at by the engineer and is necessarily a sort of compromise.

The board holds—and its dictum is supported by the whole consensus of the profession—that either a suspension or a cantilever bridge could be built and would be a safe and serviceable structure, with a clear span of either 2000, 3100 or 3200 feet—the first being the agreed minimum, since although a center pier might be permissible so far as navigability of the river is concerned, it would be almost out of the question on account of the immense depth and unknown cost of caisson work through water, silt and sand. Speaking broadly, there are four possible alternatives, since the prohibition of false work excludes all other systems but the suspension and the cantilever. These are: (1) the 2000-span cantilever, (2) the 2000-span suspension, (3) the 3100 or 3200 cantilever, and (4) a suspension bridge of equivalent span. The board inclines to favor the modified combination system of a suspension bridge with a heavy stiffening truss to meet the requirements of a six-track full-speed rail-

way traffic. Railroad men almost unanimously prefer the cantilever because of its rigidity, as against the light suspension system; but the board's favored design would satisfy them.

As to costs, the board prudently declined to commit itself, making estimates only by way of comparison between different systems, assuming certain bases of duty and cost of material—where these are comparable. Even here the board's figures have been criticised adversely, it being shown that the estimates of 4½ cents per pound for steel work and 8 cents per pound for wire work were both in excess of what responsible constructing companies were ready to bid.

The New York and New Jersey Bridge Company itself favors the shorter distance (2000 feet) cantilever, as better adapted to heavy railway traffic and quicker to be constructed. Comparison is mainly between this and the long-span suspension designs.

The costs, so far as the bridge construction alone is involved, range from somewhere in the twenties to the thirties of millions of dollars, and various minor deviations in the plans bring out a series of estimates hardly worth citing, for, to speak plainly, they are mere guesses for the most part upon unknown data and unprecedented conditions. It is comparatively plain sailing to compute weights, stresses and sections for either form of bridge, and to get bids for construction of the superstructure which will bring the actual cost within definite limits; but as to the caisson work and pier building under adverse conditions so far beyond all previous experience, all figuring is uncertain.

However, these are not the matters we wish to emphasize here. Granting that a "safe and serviceable" bridge can be built across the Hudson at New York—as we all do, and as we all know must be built sometime, unless the tunnel schemes turn out more promising than at present—the great questions for the public are: Will such a bridge pay? Is it wanted so much now that the investment is warranted?

"Well, and what business is it of the public whether the enterprise is financially successful or not?" it might be in turn asked, "provided the bridge company takes its own risk and fulfills its charter requirements?" It does not do to "jump on" private enterprise, however daring; for if such a spirit had always prevailed we should have had no railroads, no steamships, no telegraphs—hardly any of the achievements of modern enterprise. And now that countless millions of capital are ready at hand to back any project that promises good returns, the facilities are vastly enlarged and the engineering possibilities almost boundless, so that the carving of Mount Athos, the ultimate completion of the Panama canal, the French Atlantic-Mediterranean canal, and a host of ancient and modern projects are well within the limits of engineering practicability and financial support. But in this case the public has a decided interest. The company starts with a creditable independence and fair dealing, but it will want to market its shares and bonds. It will come in conflict with other transportation interests. It will inevitably collide with private ownership of real estate. All these are not finally deterrent if the enterprise is shown in advance to promise profit. But who can say?

We honestly believe that the total cost of the proposed Hudson river bridge between New York city and New Jersey at somewhere between 55th to 65th streets, New York, will not be the $22,000,000 of the bottom estimate, but something like $100,000,000, with an indefinite margin that no one can foresee, by the time that the piers are put in, the bridge is built, the terminal property condemned and acquired, and the whole machinery in working order. In the end it will be found that the real estate problem will be the dominant one. Experience in all similar cases—and notably in that of the Brooklyn bridge—shows that the mere engineering and construction costs are only a fraction of the final total. If the New York and New Jersey Bridge Company have fairly computed all these outside but preponderant costs, and are satisfied that their estimated income will cover interest charges let them go ahead—and success be with them!

Mine Titles.

In his very clear review of the history and effects of the United States mining law, printed elsewhere in this issue, Mr. Wynkoop draws attention to the underlying principles which should regulate ownership of mineral-bearing ground. That these principles are generally recognized is sufficiently shown by the almost unanimous tone and tendency of the laws in all countries which have mining laws at all. Putting the matter in somewhat different shape from that worked out in Mr. Wynkoop's able discussion, it may be said that there are three several interests at stake.

First in importance comes that of the commonwealth, which requires that natural resources should be availed of to the fullest economic extent, and that no one should be allowed to monopolize such resources and let them lie stagnant because of inability or unwillingness to develop them, or to hold them dormant for speculative purposes. To this end most countries rich in mineral resources jealously maintain their fee to the mineral ground, whether they are ruled in one way or another, as under monarchies, as republics, or as colonies instituting their own laws. In this respect the United States law is more liberal than that of any other country. The condition required for maintenance of title to unpatented claims is that at least $100 worth of labor must be done yearly on each location, and this has been construed so as to permit concentration of work upon one of a group of claims, to apply to improvements (such as buildings and roads) not strictly mining work, and recently even this very moderate requirement of annual assessment work was suspended for one year by act of congress. But however strict or lax the laws of the different mining countries may be, the same principle of occupation and use is recognized. The liberality of the United States mining law may be ascribed to the intent of its framers to stimulate prospecting and the finding of mineral, as well as to develop and utilize it when found. If, however, the small amount of assessment work is not performed, the claim is open to relocation.

It is regarding the second interest—that of the holder—that the practical difficulty in formulating equitable laws comes in. As a matter of fact and record, there is hardly a mine of any importance held under the United States law that has not been through the courts or is not still subject to litigation. This litigation is not only extremely costly, involving the employment of high-priced lawyers and expert witnesses, but it is tedious and wholly uncertain. A case may take years in settlement, passing from district courts finally up to the U. S. supreme court, with frequent reversals and with the chance (which has sometimes proved a reality) of the supreme court reversing itself. The remedy is plain. If the extra-lateral right—that of the owner of an "apex" to follow his lode (or other form of deposit) down on the dip beyond the vertical projection of his side lines—were withdrawn, and title secured to everything within the vertical planes of surface boundaries, and to that only, there would be no more uncertainty about mining property than ordinary real estate, the issue narrowing down to a mere matter of survey, the actual presence of mineral, and compliance with assessment-work requirements. To give the owner a fair chance underground, if his lode dips at a small angle, the width of claims should be increased and something taken off the length to equalize areas. About 900 × 900 feet is considered a fair-sized surface area; but whatever the size determined upon, it would be possible to fix upon some form of "square location" (which does not necessarily mean square literally, but merely a shorter and wider area with finite boundaries) that would be generally satisfactory. As Mr. Wynkoop points out, the intention of the capable commission that drafted the law of 1872—the existing one—was to restrict the owner to working within all of his boundaries, which provision was amended in favor of extra-lateral rights by the wishes and arguments of those who at the time had in mind only the typical "true fissure" veins in granite and eruptive rocks, and had no idea of the perplexing irregularities of deposits in limestone and the host of deposits which almost elude classification.

The third interest is bound up with that of the commonwealth. It is the inherent right of men to occupy that which is of no service to others. Here self-interest works in behalf of the public weal. But it is possible to carry the principle too far. It is quite true, as Mr. Wynkoop's miner-orator declares, that "air, water, the earth and all its mines belong to humanity and no man has a right to monopolize any more of any one of these than he can use"; but when it is attempted to embody the doctrine in a definite code we are treading on dangerous ground. He who has expended his thought, his time and his money in developing and making useful mineral ground that without such effort would have lain useless, has created a value and should be protected in its holding so long as he conforms with the higher principle of the public good. A rigid enforcement of the assessment work provision secures the latter purpose. Just now the one and all-important demand is for security of title. To effect this our anomalous system of land patents was devised. But even such patents do not absolutely protect, any more than patents to inventions, or copyrights, or trade-marks; while they have the deterrent effect upon the mining industry of permitting mineral territory to remain unworked. The many amendments and substitutions to the United States mining law heretofore proposed are by no means satisfactory. They tend to further complicate what is already unnecessarily intricate. The guiding principle of the existing law is just, both to the nation and to the individual. It is in the forced adaptation of fixed law to widely varying geological conditions that the trouble comes in. Once simplify it by excluding the need of uncertain expert testimony and the interpretation of varying natural conditions, and retain or increase the requirement for utilization, and the tenure of mining territory will become as safe and as equitable as that of common real estate. No new law can be retroactive and invade existing rights, but there is still time to provide for the future, and there is an urgency that this should be done, to the end that mines worth working shall be worked and those not profitable or prospectively profitable shall be abandoned, and that the present constant drain for legal expenses may be done away with.

Electric Competition with Steam Railroads.

No small amount of newspaper comment has been occasioned by the statement of the president of the New York, New Haven and Hartford railroad company, in his report to the stockholders of that corporation at the annual meeting last month, to the effect that the increasing application of electricity as a motive power on highways, is likely to appreciably diminish the earnings of steam railroads from local travel, and that the latter will be compelled to lessen their local service in proportion to their diminished business. It is further suggested by him that there is an element of injustice in the demands of the public upon the steam railroads for expensive stations, prompt and frequent train service, and protection of crossings by gates and flagmen, in competition with the free rights-of-way and cheaper construction of electric railroads. The local newspapers have within the past month chronicled a number of instances, mostly in New England, in which the local steam-railway service has been materially curtailed in consequence of electric competition. With the revival of general business, nothing is more certain than that the number of these competitive electric enterprises will be largely increased. What will be the final outcome? Naturally, the citizens of the municipalities accommodated by electric lines have encouraged their construction in every possible way, by subscriptions to their stock and bonds, and by granting them almost unrestricted privileges in respect to the occupation of the public highways. The result has been to stimulate the construction of competitive electric lines in many places where, as time will demonstrate, they cannot be operated at a profit. In some instances where the local conditions are favorable, they may prove profitable and successful. In either case, nothing seems more certain than that for their own protection, the steam railroad

corporations will ultimately be compelled to secure control, directly or indirectly, of all electric street-railways which seriously compete with them. In view of this possibility, not to say certainty, it would seem to be the part of wisdom for the municipal authorities of towns to exercise a good deal of discretion in granting exclusive and perpetual franchises for the occupation of their streets and roads to electric railway companies. If they assume that the steam railroad companies will quietly submit to the diversion of an important and profitable portion of their traffic, without resorting to every possible means to protect themselves, they may ultimately find that they have made a serious mistake.

Electro-Technical Literature.

IT is with much gratification that we observe a marked improvement in the character of the technical literature relating to electricity and its industrial applications, published or announced for publication during the past year. Few persons who have not had occasion to become conversant with the subject have any adequate conception of the utter worthlessness, either to the professional worker or to the serious student, of nine-tenths of the so-called electrical books which have flowed in an ever-increasing stream from the presses of the publishers during the past fifteen years. Up to within a comparatively short time, it would have been a matter of little difficulty to have compiled a list of about a dozen treatises comprising about everything in print of real permanent value, outside the files of the leading technical periodicals Perhaps the most striking characteristic manifest in the work of the more modern electrical authors is the tendency to specialization; involving the separate treatment of each subdivision of the general subject by an acknowledged authority. Some of the more recent works of this class, such as Silvanus Thompson's Electromagnet, Crocker & Wheeler's Dynamos and Motors, Crosby & Bell's Electric Railways, Noll's Wiring, and others which might be mentioned, are models in their way, and are doing noble work in raising the standard of intelligence and good service among among young men engaged in the various electrical industries. Voluminous and heterogeneous compilations, of the Du-Moncel and Prescott type, though in their day not without their uses, are now but relics of an age that has passed away.

Sanitary Plumbing.

THE papers read before the recent Sanitary Congress in Liverpool, and the discussions these elicited again bring the dangers to health and life through the spread of infection by sewers to public attention. There can remain no doubt in the minds of intelligent and well-informed men that to avoid such dangers the whole system of house drainage should be constructed from beginning to end in accordance with the most advanced principles and methods of sanitary plumbing and sewer construction. People with small means hesitate when sanitary plumbing is named, because, in the popular mind, this term is thought to mean also expensive plumbing. The newspapers describe the gorgeous appliances and fittings going into some millionaire's houses in glowing language, and speak of this sort of thing as sanitary plumbing; and the man of small means gets the idea that sanitation is an accompaniment of splendid living only possible to the wealthy. This is a great mistake. Sanitary plumbing means nothing more than plain plumbing done on sound principles, the practical application of which need cost very little more, either in material or labor, than a defective job. It will cost the plumber who does it something more than the common, inferior sort of plumbing. It will demand more brains, knowledge, and skill. The leading plumbers in this country have acquired the leading knowledge and skill, and are prepared to do their work as perfectly as the present state of the art will permit; and if fancy work be not demanded, will do it in sanitary respects as well for the man of limited means as it can be done for a millionaire.

REVIEW OF THE INDUSTRIAL PRESS

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A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E R J..Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G .....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H .....Annals of Hygiene. *m.* $2. Phila.
A J P....Am. Jour. of Politics. *m.* $3. New York.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A J S ...Am. Jour. of Science. *m.* $6. New Haven.
A L ....The Architect *w.* 26*s.* London.
A M .....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am S....American Shipbuilder. *w.* $2. New York.
A M S.. Aust. Mining Standard. *w.* 30*s.* Sydney.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A P R...Aus. Pastoralists' Rev. *m.* 20*s.* Sydney.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
A S M E..Am. Soc. of Mec. Eng. *m.* New York.
B ..... The Builder. *w.* 26*s.* London.
B A... .The British Architect. *w.* 23*s.* 8*d.* London.
B B .....Brick Builder. *m.* $2.50. Boston.
B C .....Boston Commonwealth. *w.* $2.50. Boston.
B D ....The Black Diamond. *w.* $3. Chicago.
B G S....Bul. Am. Geog. Soc. *q.* $5. New York.
B I S . .Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B M ....Banker's Mag. *m.* 18*s.* London,
B T J ...Board of Trade Journal. *m.* 6*s.* London.
B U W .Bul. of the Univ. of Wisconsin.
B & W. Builder and Woodworker. *m.* $1. N. Y.
C ..... .Compass. *m.* $1. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A . Canadian Architect. *m.* $2. Toronto.
C & B... Carpentry and Building. *m.* $1. New York.
C E ....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N .. Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
C G ...Colliery Guardian. *w.* 27*s.* 6*d.* London.
Ch .....Chautauquan. *m.* $2. Meadville, Pa.
C M ....Century Magazine. *m.* $4. New York.
C M R...Canadian Mining Rev. *m.* $1.50. Ottawa.
Cos .....Cosmopolitan. *m.* $1.50. New York.
C R .....Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
D ..... ."Dixie." *m.* $1.50. Atlanta.
D E.....Domestic Engineering. *m.* $2. Chicago.
E.....Engineering. *w.* 36*s.* London.
E A.....Electrical Age. *w.* $3. New York.

E A S....Eng. Asso of the South. *m.* $3. Nashville.
E E .....Electrical Engineering. *m.* $1. Chicago.
E E L....Electrical Engineer. *w.* 19*s.* 6*d.* London.
E E N Y..Electrical Engineer. *w.* $3. New York.
E G.....Engineers' Gazette. *m.* 8*s.* London.
E I.....Electrical Industries. *m.* $1. Chicago.
E L.....Electricity. *w.* 7*s.* 6*d.* London.
El.. .....Electrician. *w.* 24*s.* London.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y
E N.....Engineering News. *w.* $5. New York.
Eng.....Engineer. *s-m.* $2.50. New York.
EngL... Engineer. *w.* 36*s.* London.
E N Y....Electricity. *w.* $2.50. New York.
E P.....Electrical Plant. *m.* 6*s.* London.
E R.....Engineering Record. *w.* $5. New York.
E Rev....Engineering Review. *m.* 7*s.* London.
E R L.....Electrical Review. *w.* 21*s.* 8*d.* London.
E R N Y..Electrical Review. *w.* $3. New York.
E S W P...Proc. Eng. So. of W. Pa. *m.* $7. Pittsburg.
E W.....Electrical World. *w.* $3. New York.
F .. ..Forum. *m.* $3. New York.
F D.....The Foundry. *m.* $1. Detroit.
F R.....Fortnightly Review. *m.* $4.50. London.
F W.....Fire and Water. *w.* $3. New York.
F'y.....Fairplay. *w.* 32*s.* 6*d.* London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
G & F....Garden and Forest. *w.* $4. New York.
G M.....The Geol. Mag. *m.* 18*s.* London.
G R.....Good Roads. *m.* $1. New York.
G W.....Gas World. *w.* 13*s.* London.
I A.....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron & Steel Trades' Jour. *w.* 25*s.* Lond
I C B.....Carpenter and Builder. *w.* 8*s.* 8*d.* London.
I C T.....Iron and Coal Trades. *w.* 30*s.* 4*d.* London.
I E.....Indian Engineering. *w.* 18 Rs. Calcutta.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
Inv.....Invention. *w.* 11*s.* London.
Ir Age..Iron Age. *w.* $4.50. New York.
Irm.. ...The Ironmonger. *w.* 10*s.* London.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
I W .. ..Indus. World. *w.* $3. Chicago
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E..Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J G L.....Journal of Gas Lighting. *w.* London.
J M S I..Jour. Milit. Service In. *b-m.* $4. New York.
J M W A..Jour. of United Metal Workers of America. *w.* $1. N. Y.
J N E W..Jour. N E Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J S A .. Journal of the So. of Arts. *w.* London.
J U S A..Jour. U. S. Artillery. *q* $2.50. Ft. Monroe.
L A.....The Landscape Architect. *m* $1.50. Rochester.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L. H. P..Light, Heat and Power. *m.* $3. Phila.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
L P.....Louisiana Planter. *w.* $3. New Orleans.
M.....Machinery. *m.* 9*s.* London.
M A . ..Machinery. *m.* 50 cts. N. Y.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M E.....Marine Engineer. *m.* 7*s.* 6*d.* London.
Met W...Metal Worker. *w.* $2. N. Y.
M G.....Manufacturer's Gazette. *w.* $3. Boston.
Mill.....Milling. *m.* $2. Chicago.
Min. R...The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $3. Denver.
Min W..The Mining World. *w.* 21*s.* London.
M J. ....The Mining Jour. *w.* £1. 8*s.* London.
Mi N....The Monumental News. *m.* $1. Chicago.
Mo ... The Monist. *qr.* $2. Chicago.
M R .....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M W.....Mechanical World. *w.* 8*s.* 8*d.* London.
N..... Nature. *w.* $7. London.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C.....Nineteenth Century. *m.* $4.50 London.
N C B...National Car Builder. *m.* $2. New York.
N E M...New Eng. Magazine. *m.* $3. Boston,
N P R...Nat. Popular Review. *m.* $2.50. Chicago.
N S R....The New Science Review. *qr.* $2. N. Y.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P..... ..Paving. *m.* $2. Indianapolis.
P A .....Progressive Age. *s-m.* $3. New York.
P E C P..Proc. Engineer's Club. *q.* $2. Phila.
P Eng...Practical Engineer. *w.* 10*s.* London.
Pl D.....Plumber and Decor. *m.* 6*s.* 6*d.* London.
Pr.....Power. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1 New York.
R E M....Railway Engineering and Mechanics. *m.* $1. Chicago.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R M.....Roller Mill. *m.* 50 cts. Buffalo, N. Y.
R of R...Review of Reviews. *m.* $2.50. New York.
R P L....The Railway Press. *m.* 7*s.* London.
R R.....Railway Review. *w.* $2. Chicago.
R & T...Roofer and Tinner. *m.* $1. N. Y.
R W.....Railway World. *m.* 5*s.* London.
Ry T.. . The Railway Times. £1. 5*s.* London.
S .. ..Stone. *m.* $2. Chicago
S A.....Southern Architect. *m.* $2. Atlanta.
San.....Sanitarian. *m.* $4. Brooklyn.
Sc.....Science. *w.* $3.50. New York.
Sc A ...Scientific American. *w.* $3. New York.
Sc A S ..Scientific Am. Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
S E .....Stationary Engineer. *w.* $2. Chicago.
Sc Q.....Scientific Quarterly. *q.* $2. Golden, Col.
Sea.....Seaboard. *w.* $2. New York.
S Ec.....Social Economist. *m.* $2. New York.
S In.....Stevens' Indicator. *qr.* $1.50. Hoboken.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S L.....Steamship. *m* Leith, Scotland.
S M.....Scientific Machinist. *s-m.* $1.50. Cleveland, O.
S M Q....School of Mines Quarterly. $2. N. Y.
So L.....Sou. Lumberman. *s-m.* $2. Nashville.
S R ...Sanitary Record. *m.* 10*s.* London.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P .....Sanitary Plumber. *s-m.* $2. New York.
S R G ...Street Railway Gazette. *w.* $3. Chicago.
S R J ...Street Railway Journal. *m.* $4. New York.
S R R...Street Railway Review. *m.* $2. Chicago.
S V..... Safety Valve. *m.* $1. New York.
T .. ..Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E..Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
Tr.....Transport. *w.* £1. 5*s.* London.
Tr A M E..Trans. Am. Ins. of Mining Eng. N. Y.
T W A ..Trans. of the Wis. Acad. Madison.
W A....Western America. *m.* $1. Omaha.
W E.....Western Electrician. *w.* $3. Chicago.
W R.....Westminster Review. *m.* $4.50. London.

ARCHITECTURE & BUILDING

Mr. Arthur Rotch, Architect.

THE *Architectural Review* devotes considerable space to an obituary notice of Mr. Arthur Rotch, who was a Boston architect of large practice, but whose name will be remembered longer for what he has contributed toward the general advancement of the profession, than for the special architectural work he has done. In connection with other members of the Rotch family he founded what is known as the Rotch Traveling Scholarship and he left munificent legacies to the Boston Architectural Club, the Boston Museum of Fine Arts, the Architectural Department of the Massachusetts Institute of Technology, and to the Architectural Department of Harvard, in founding which he largely assisted.

The article named is, however, valuable not so much on account of its mention of the services rendered to the profession by a man of lofty and liberal mind (though this may perhaps be of service in stimulating like liberality in others), as in what its author has to say in connection with this, touching the obligations of architects toward draughtsmen in their employ.

We believe that the obligation of the architect towards his draughtsmen does not cease with the payment of the latter's weekly stipend. Setting aside moral obligation as a term too vague to have any specific application, we think it may be shown that it is for the architect's benefit to aid in every reasonable way his draughtsman's education. It will be found generally true that the architects who have attained eminence have either had a liberal education in early life, or have by singular diligence made up the deficiencies of their education in all lying outside their profession of architecture. The principle is laid down "that architecture is a means of expression, and only that," and it seems to the reviewer that if this be denied the denial would imply away all that is comprised in architecture considered as an art as distinguished from building considered as a trade. A man may be able to execute fine drawings, to imitate what others have done,—in short, may be an efficient assistant in the office of an employing architect, without being himself an architect; but when it comes to the expression of ideas and conceptions the writer of the article under review very pertinently remarks: "Except a man have something to express, all his facility is but a poor and unprofitable achievement."

The importance of a good acquaintance with the standards of other arts, of literature, history, and social life, is apt to be underestimated by the beginner in architecture who comes early to his task. There is so much that appears of immediate and urgent importance for him to acquire,—technical ability of hand, the training of the eye, a knowledge of the conventional forms of design that he sees so readily employed by those above him,—all these things he wants to become proficient in; and the keener his ambition, the more undivided his attention to them. Thus it happens that many draughtsmen whose early training has not developed in them a wide interest in the things that tend to make men broad in judgment, and cultivated in choice, go for years happily pegging along in a narrow routine of study, only to discover at a fatally late day that they have been missing much that was best in the opportunities of the past.

The value of many things in influencing taste is suggested in conclusion. The sources of mental refreshment and cultivation that each man finds especially helpful may be communicated to the student, and a train of delightful results may follow of untold value. "It is only setting wide the door and inviting him in; it doesn't seem much, but it is a great deal."

Rambling Sketches.

MR. THEODORE OSCAR FRAENKEL, traveling for his health under advice of his physician, and finding absolute rest irksome, disobeyed the doctor's injunction, and amply provided with sketching materials, made sketches and notes, from which he has written for *The Inland Architect* an article describing and illustrating what he saw. The sketches are of examples of colonial architecture, such as could be seen on a southern trip, taking in Baltimore, Washington, Georgetown, Alexandria, and other cities. Speaking of the quaint old town of Alexandria, Mr. Fraenkel says:

It is a blessing for the old place that it has

not grown faster; for there would be little left to interest one except the historical spots made famous by our forefathers. By all means keep the quiet architecture in the town if you want to keep the place. The present fashion of continental hats and capes seems quite in keeping with the old place and very pleasing to the beholder. I wandered about the grand old spot, Mt. Vernon, with its innumerable accessories, kitchen, servants' quarters, spinning house, carpenter shop, well-house, all separate from the main building, and built in Colonial feeling. The interior of the building shows the old Colonial work of Washington's time and furniture of the period, loaned by the different states.

A sketch of Christ Church in Alexandria shows one of the specimens of church architecture characteristic of the colonial period, of which a few yet remain here and there. In looking at it one easily fancies the Sunday morning scene, when the old-time Virginia planters assembled under its broad porch, while the bell in the tower at the corner of the building rang out over the adjacent fields of corn, wheat, oats, and tobacco. The sketches made in other places as the artist journeyed along will recall much that previous travelers have found interesting. A sketch of an old house in Covington, Kentucky, with its two broad verandas extending the entire length of the building on opposite sides, reminds one of the comfort and hospitality that were characteristic of southern mansions in *ante bellum* days. The building seems a standing invitation to enter and partake of the feast of good things always spread on the tables for welcome guests, visiting these old Kentucky homes. Mr. Fraenkel says he does not want to be understood as preaching "Colonial," but he maintains "that there is a lesson in the old work," and that "the impression of it was received almost direct from good work on the other side of the water." He speaks of the old work in New Orleans, mostly to be found in the French quarter, as a great attraction to people from the North. The natives call it "Spanish Colonial."

"There is a certain honesty of purpose in the Colonial. Its symmetry and balance in most everything we find it difficult to reproduce, because of the different modes and ways of building, the materials used, and principally the radical change in planning our homes at the present time. Naturally enough, every time Colonial work is attempted we are apt to design in Renaissance, which is certainly traveling in the right direction. Colonial itself is only a license to do what we want, and this freedom we can use in domestic architecture. It is just that freedom that an American architect wants, but the trouble so far has been, we have had too much. Some who have never had the opportunity of visiting the old places would find it delightful recreation, and would see there something in architecture that is truly American in spite of all our efforts to produce something new for our homes."

A certain picturesqueness always attaches to the old home life of the South, and this was reflected in its architecture, not only in the cities but in the country homes of the planters. If there ever was a house that seemed to smile a friendly welcome to those approaching it, it was an old colonial mansion. If we have gained anything by more recent types of construction, we have sacrificed this noble attribute of a home. There is a sort of "keep-off-the-grounds" expression to the more pretentious designs of recent country mansions. Many of them are beautiful, but they do not seem to invite approach. The old colonial mansion seemed to say "walk right in, tarry awhile; rest here"; and he who accepted the invitation, if worthy of the hospitality thus extended, was never disappointed. Those who read Mr. Fraenkel's article, and who can remember the South as it was even forty years ago, will recall this feeling and will find much pleasure in recalling it.

The New Style of Architecture.

C. BRYANT SCHAEFFER, in the September number of *The Inland Architect*, writes in the same line of thought as that which runs through his article on the Origin of Gothic Architecture, reviewed in this department of our October number. The same esoterism pervades what he has to say upon this subject as was noticed in his former article. If it were desirable to avoid this, it could hardly be avoided in following out the line of thought adopted;

and as Mr. Schaeffer is evidently not writing for the laity, but presumably for architects of high attainments, he is justified in soaring a considerable distance above the heads of common people.

"How are we to arrive at a new style of architecture? It is a query that is becoming more classical than the solution. Each interrogator dwells at length upon the perplexing circumstances that are true enough, and when auditors have reached the lowest possible depths of despondency, a set of expedients, rules, or guides are produced, which are warranted by their originator to bring about speedy realizations. Some foam is thrashed and some bubbles rise upon the air that glint with color, but a little whiff and they are gone.

"Possibly it is too often overlooked by the architectural enthusiast that rules came after art epochs and never before, and also that æsthetic expression does not exercise in the neighborhood of disputation. The widest course is in a close contact with the inspirational development of the common, middle-class world and faith that the mysterious question is already solving itself upon the boards of the architectural designer.

"All architectural styles have unconscious beginnings. The roots have been long hidden from view when the art has become architecture. The starting, deep down in the shadows of primordial man, first records sensations that are a revelation to the human."

The author repeats his proposition that there are only three great schools of classic architectural art, namely, "the Mohammedan, Greek, and Christian styles,"—the first, effeminate; the second, masculine; the third the gothic, which he makes synonymous with "Christian." "The persistency of man in search of the higher planes of human possibilities sent the pinnacles of cathedral art skyward from the fields of Europe." The Byzantine, Romanesque, Roman, and other styles, which the author holds to be "departures from Saracenic and Greek arts," and variations of the Gothic among Venetian and French developments are regarded as representing transitional phases of civilization.

The author, in conclusion, asserts that the origination of a new style depends upon giving "to the human consciousness a necessary fourth principle"; and he implies a doubt that the depth at which architectural art has its foundations is sufficiently recognized.

The Academy at Athens.

THIS building, which we are told was intended for a body of scholars modelled after the celebrated Institute de France, and which "was erected at the expense of the late Baron Sina, a wealthy Greek of Vienna, from the designs by Hansen, a leading architect of the same place," and constructed under the direction of the architect, Ziller, who practises in Athens, is made the subject of illustrated description contributed to the *Architectural Review* by Mr. Thomas A. Fox. The illustrations are exceedingly beautiful, and the descriptive text gives a charming account of a modern building comprising, as far as possible, the features of classical Greek architecture.

There are few modern structures which possess greater interest for the student of classic architecture than the academy at Athens, for it is a building constructed of marble from the same quarries as the Parthenon, and enriched with decorations in polychrome carefully studied from the examples of the best period, which lay close at hand. It is from this building, therefore, if from any standing at the present time, that we must judge of the effect of the Greek temple in its perfection, with its white surfaces and brilliant decorations in red, blue, and gold. For no one can doubt, in view of the recent discoveries, that the Greeks used color with a lavish hand on both sculpture and architecture.

Besides being a most interesting study in itself, the building forms one of the most remarkable groups of buildings in modern Athens, to-wit: the Academy, the University, and the Library. It gives one a curious feeling of incongruity to notice in the foreground of the front view of the Library building, which is one of the illustrations, the ubiquitous telegraph pole, rearing its modern ugliness of cross bars and insulators before a building of classical beauty. The old and the new thus brought into juxtaposition, seem each wholly unfitted for the presence of the other.

The author regards "the polychrome decoration of the exterior as the most in-

teresting feature of the building; red, blue and a generous amount of gold having been used with most successful results." A description of this decoration concludes the article.

The Angle of Content.

PARAPHRASING the technical term "angle of repose" for a title, a writer who signs his initials H. H., has contributed a pleasant article to *The American Architect* upon designing a small country house. However small may be the technical value of this paper as an aid in architectural work (and probably its author would not claim much for it in this way), it is suggestive and expressed in delightful language. The writer, if he does not recount an actual experience of an attempt to select a type, and upon this type to design a small country house, imagines such an attempt, and paints it so vividly, and with such a vein of quiet humor, that he makes sure of any reader who, attracted by the unique title, peruses the first paragraph.

He represents himself as having long considered the requirements. He now knows exactly what he wants.

On the first floor, there must be a large living-room, twenty feet by thirty feet. The windows are to be broad and the ceiling low. On one of the longer sides, a generous fireplace; opposite, a succession of low windows opening on a fine prospect, preferably to the west or southwest. A broad hall. A dining-room, fifteen feet by twenty feet, and the necessary pantries and kitchen. Further, there is to be a small entrance porch, and in addition, a wide living porch on another side of the house. This latter condition is important; it provides that the family group shall not be disturbed by every chance visitor. Upstairs, I want four chambers, perhaps fifteen by twenty feet, and a good-sized bath-room. Then in the attic, there is to be a trunk-room, a work-shop and a servant's room. I will have no store-room. They are immoral institutions, tending to the accumulation of useless rubbish, and the withholding from your poorer neighbor of much stuff that will be of benefit to him! In this ideal household of mine we give away everything we cannot use. This induces a benevolent feeling on our part,—and makes house-cleaning easy.

But he finds it takes time to evolve the house. After all the requirements named are duly fixed upon, the exterior bothers him. After he has carefully considered types, in doing which he goes over the whole category of styles, the Colonial, Early English, Anne Hathaway, Italian, etc., he fixes at last upon the châlet. Throughout this imaginary ramble in search of a style, the author treats us to many agreeable bits of humorous reflection.

"I am fortunate in knowing exactly what sentiment I wish my house to express. I am at great trouble to find out how to give the sentiment adequate expression. We of the laity do not often state the problem so plainly. This is the reason we get on so badly with our architect. Sentiment is vague. There is little practice in the art of expression. We fail to catch our inner motive. We fail to communicate it. As a result our architect succeeds in producing something that pleases neither himself nor us. We vote him a dull fellow after all, and lament the days of the old masters."

But he makes progress, by adopting the method of exclusion, and finally decides, as has been said, upon the châlet. Here he meets with yet a final difficulty. "It is with the angle of the roof." This gives the clue to the author's choice of a title for a most entertaining article—the angle of the roof of his imaginary châlet.

"But the final difficulty still remains. It is with the angle of the roof. In a châlet everything depends upon this. If the roof is too steep, the house has an upstart look, as if the sides had been smashed together in bringing it from Switzerland,—just what I do not want. If the roof is too low, the effect is depressing and there is total loss of self-respect, also just what I do not want. I have tried all angles. I have studied photographs. I bought large sheets of manilla paper. I have covered them with elevations of all sorts of châlets. It has taken a prodigious amount of work. But at last I have succeeded. I have just found the right angle,—the angle of content. I am rejoiced. I shall not celebrate by killing a hundred oxen. Times have changed. I shall go to the Symphony concert instead. For the rest, it is all plain sailing. I shall leave the details to my architect. He is not such a dull fellow, after all. But I shall watch him, goniometer in hand.

"It occurs to me that I have omitted to tell

what I found the angle to be. Perhaps this is just as well, however, for if one did not agree with me, one might be disposed to discredit all the other wise things I have been saying, and that I should much regret."

Home in the Cottage.

"IN spite of all that circumstance has done to create distinctions of class amongst the human race," says the *British Architect*, "the minds and desires of mankind seem to be pretty generally the same the world over. Apparently one man gets the advantage over another by a bit of extra wealth, a more liberal education, or a better bringing up, but beyond this human nature shows little or no difference between high and low, rich or poor. The joys and sorrows of the one are those of the other, and to both there comes times of longing desire when the need for bodily rest and mental quiet craves satisfaction."

There can be no denying the fact that the home itself must to a greater or less extent always influence the lives of its occupants, though it by no means follows that the most beautiful make the most beautiful lives. But convenient, comfortable, cleanly homes, with something of artistic simplicity and finish about them, at any rate make for the refinement and elevation of heart and life; this at least goes without saying. To the rich and fairly well-to-do folks the provision of comfortable and artistic homes is a matter of individual taste and personal effort. To the poorer portion of the community there is practically no choice left but to take such as they can obtain and make the best of them. For this latter class, whose homes are strictly limited to the cottage, properly so-called, or artisan's dwellings, the landlord and property owner is the only hope, and a very forlorn one it is, generally speaking. Just now and then one comes across a bona fida attempt to make the cottage, or the small house, something better than the average hut-like arrangement that usually passes muster for the artisan, and the often more poorly-off city clerk. Such an attempt we noted in a small Surrey village last week, where perhaps one might least of all have expected to find it. Almost hidden behind the great hedgerow skirting the main road, just the red-tiled roof of a row of new cottages, with their rough-cast chimneys, with red-brick finishing, first peeped over. Then through an opening in the hedge we got a full view of one of the cottages with its creamy-yellow rough-cast walls, its trim little casement windows, and the cosy-looking porch, making up as satisfactory an exterior as we ever remember having seen on such very small property. The timber work of the porch, coated with Stockholm tar, and the grey color of the door set in a frame painted white, make up an admirable effect with the color of walls and roof.

The article then proceeds to give some interesting sketches and descriptions of the cottages spoken of, the home feeling, conspicuous in what has been quoted, being the keynote of an exceedingly readable article.

Cement and Concrete Construction.

MR. ROSS F. TUCKER has contributed to *The Brickbuilder* an excellent practical paper on cements and concrete construction as applied in engineering works. The author discusses the composition of various cements in detail, under the assumption that the constructive value of cements depends very largely upon the variation in the proportion of the elements that compose them. He also calls attention to "the manner in which we may progress in the study of cements from their simplest form as they exist in lime mortar to the complex hardening of the best Portlands." The author explains by reference to a preceding paper printed in the same publication that "the hardening of a cement is due to a chemical union between two and often three primary substances—lime, silica, and alumina,—and that as far as the formation of the concrete is concerned, it is of no consequence whether this union takes place in a few hours or continues slowly through hundreds of years."

The author therefore begins the discussion with the consideration of lime mortar "which though not ordinarily called a cement, inasmuch as it shows none of the qualities belonging to a real cement within ordinary limits of time," ultimately "results in a hard compound in all respects similar to a cement."

The length of time required to bring this about depends on the quality of the sand used in making the mortar; and with ordinary sand which contains little soluble silica, the process may continue for centuries, while with

pozzolanas, which are rich in soluble silica, the hardening is of sufficient quickness to warrant the use of these mortars in damp localities and even under water.

The hardening of lime mortar, practically considered, being due to the absorption of carbonic oxide from the air, the author proceeds at once to that kind of lime mortar "which shows distinct setting properties; namely that made of pozzolana and those remarkable sands used so extensively in the buildings of Rome." Of pozzolani, and other similar sands that unite quickly with nascent lime, it is stated that they are variable in quality, some being more adapted to use in wet localities than others. "The santorin earths are especially noted for their power of conferring hydraulicity upon fat limes, while trass has been extensively used in Holland in submarine works of importance." A comparison of the elements of different pozzolanas, is made. Pozzolana of Rome contains in 100 parts 48 parts of silica; 14.3 of alumina; 3.9 of magnesia; 10 of oxide of iron, 7.7 of lime; 4 of alkalies; 3 of sand, and of water, 9, 1. Santonin earth and trass are both richer in silica, alumina and alkalies, than the Roman pozzolana, while they contain neither sand nor water. Trass contains more lime than either of the others, and santonin earth less. "The union that takes place is precisely the same one that occurs when Portland cement is wet, namely the formation of a complex double silicate of lime and alumina; so that in the making of concrete the ultimate results are similar whichever process is used."

From these cements that have no distinguishing qualities as cements uutil their component parts are brought together in mortar, the author proceeds to a second general class—those which have an individual existence as cements, and are used as such; and he also subdivides this class into two kinds, the natural and the artificial. In the first of these subdivisions he places all the so-called Roman cements as used in England, all hydraulic limes as found in France, Belgium, and the shores of the Mediterranean, and the Rosendales, which have extended to America."

After a discussion of the qualities of these cements he passes to the second subdivision, which he treats under the head of "Portland Cements." Of the German Portland cements he says they are the finest in the world, in all respects; and an engineer may be at ease when his work is being done with these standard cements." English Portlands are inferior in that they "are more variable, coarser ground, and less economical." He says the processes of manufacture differ widely in the two countries, and possibly the characteristics of the two nations are shown in the results of their work. American Portland the author does not hold in high esteem.

"The Portland cements of American manufacture have a long road to travel before reaching the standard of excellence achieved by our rivals across the water; but with the great quantities of material suitable for this work at hand, it is only a question of time when American ingenuity will devote itself to the production of a domestic cement of equal quality of any in the world. The writer is not aware of the existence of a cement plant in the United States in which the production is carried on precisely as in Europe, nor is the name 'Portland' justly assumed by a great majority of American cements. It is doubtless true that several grades of domestic cement have attained a high standard and are suitable to use in important work, but they are few; extraordinary care must be observed in their use, and every precaution taken to guard against variation, for, until that is absolutely overcome, no cement can hope to take precedence of those excellent products which by long and successful use have proven themselves worthy of the highest regard, and which have won for themselves the first place in the confidence of professional builders."

Preservation of a Relic.

A CORRESPONDENT of the *British Architect*, in a note too short for indexing, writes of a project for rescuing one of the most interesting of the ecclesiastical memorials of Sussex. This relic is the pre-Reformation Vicarage or clergy-house adjoining the church of St. Andrew, colloquially known as the "Cathedral of the South Downs," which is the parish church

of Alfriston, three or four miles to the northeast of Seaford, and in a district dear to the hearts of antiquaries. The house is a modest, half-timbered edifice of the fourteenth century, apparently of contemporary date with the church; and is constructed of oak framing, with the interstices filled in with "wattle and dab." In plan it consists of a central hall, 23 feet by 17 feet, the entire height of the building, with an open-timbered roof with large cambered tie-beams and molded king-posts, after the manner usual in the ecclesiastical buildings of Sussex.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review Other abbreviations are, Ill=Illustrated; W=Words.

*24947. Uses for Terra Cotta in Modern Buildings. Ill. George M. R. Twose (E Mag-Nov.) 3000 w.

*25001. Uninhabitable Houses in Glasgow (A L-Aug. 31.) 3000 w.

25036.—$1 50. Notes upon Testing Building Stones. F. Lynwood Garrison, with Discussion (T C E-July.) 3500 w.

*25061. The Limestones of Indiana. Maurice Thompson (S-Sept.) 1400 w.

*25156. Furnishing Colors. W. T. Coghlan (I C B-Sept. 7.) 1100 w.

25177. Colonial Architecture in Western Massachusetts. Ill. G. C. Gardner (A A-Sept. 15.) 2500 w.

25178. The Problem of Waste. Warren A. Rodman (A A-Sept. 15.) 1500 w.

25181. Grading Yellow Pine Finish (D-Sept.) 1100 w.

25207.—75 cts. Mr. Arthur Rotch, Architect (A Rev-Vol. III, No. 3.) 1200 w.

25208.—75 cts. Charles Bullfinch. Ill. Charles A. Cummings (A Rev-Vol. III, No. 3.) 2200 w.

25209.—75 cts. The Academy at Athens. Ill. Thomas A. Fox (A Rev-Vol. III, No. 3.) 1200 w.

25245. Mediæval Roof Tiles (R & T-Sept.) 1000 w.

25246. Pediment Chart. Ill. W. N. (Met W-Sept. 22.) 1500 w.

*25278. Home in the Cottage. Ill. (B A-Sept. 7.) 1400 w.

†25283. Rambling Sketches. Ill. Theodore Oscar Fraenkel (I A-Sept.) 2300 w.

†25284. That New Style of Architecture. C. Bryant Schaefer (I A-Sept.) 1200 w.

25286. The Angle of Content. H. H. (A A-Sept. 22.) 2200 w.

*25343. Church Doors (I C B-Sept. 14.) 700 w.

*25344. Wren and St. Paul's (I C B-Sept. 14.) 1900 w.

25414. The Expansion of Masonry. Ill. Fr. von Emperger (E N-Sept. 27.) 2500 w.

25463. The Carlisle-O'Rourke Correspondence (A & B-Sept. 29.) 2000 w.

*25478. The Housing of the Agricultural Laborer (B-Sept. 22.) 5500 w.

*25487. Wood Carving (I C B-Sept 21.) 1100 w.

25578. Notes on Stable Buildings in London. C. H. G. (A A-Sept. 29.) 1400 w.

*25726. Commercial Design (I C B-Sept. 28.) 1900 w.

*25731. The London Building Act, 1894 (A L-Sept. 28.) 6000 w.

*25732. Wall Thickness under the Building Act, 1894 (A L-Sept. 28.) 1400 w.

Serials.

12568. Building Construction and Superintendence. F. E. Kidder (A & B-Began May 6, 1893—34 parts to date—15 cts. each).

18737. The Engineering of Architectural and Building Construction. William H. Burr (E R-Began Jan. 6—7 parts to date—15 cts. each).

18857. Electrical Science for Architects. Ill. Russell Robb (A A-Began Jan. 13—6 parts to date—15 cts. each).

20419. Modern Methods of House Painting. A. Ashmun Kelly (Pl D-Began March—7 parts to date—30 cts. each).

21618. Bay Windows and Oriels. Ill. F. Jerman (I C B-Began April 20—9 parts to date—30 cts. each).

23626. The True Principles of Pointed or Christian Architecture. Ill. A. Welby Pugin (A L-Began July 6—Ended Aug. 31—9 parts—30 cts. each).

24273. Arkansas Marbles. T. C. Hopkins (S-Began Aug.—2 parts to date—30 cts. each).

25147. Electric Power, Heating and Lighting, with Demonstrations and Notes on Their Possible Influence on the Architecture of the Future. G. Binswanger (Inv-Began Sept. 8—Ended Sept. 29—3 parts—30 cts. each).

25332. Mortars: Ancient and Modern. Fred T. Hodgson (A & B-Began Sept. 22—2 parts to date—15 cts. each).

25485. The Church Organ Architecturally and Archæologically Considered. Ill. (Abstract.) Arthur G. Hill (I C B-Began Sept. 21—Ended Sept. 28—2 parts—30 cts. each).

25577. The Influence of the Hanseatic League) on the Architecture of Northern Europe. J. Tavenor Perry (A A-Began Sept. 29—1 part to date—15 cts).

25703. Tall Office Building—Past and Future. Dankmar Adler (L A-Began Sept.—1 part to date—15 cts).

We supply copies of these articles. See introductory.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

A Criticism of the Experts' Estimates of Cost of a North River Bridge.

IN a recent letter to Mr. H. Schwab, Chairman of the Committee of the New York Chamber of Commerce on North River Bridges, Mr. W. Hildenbrand has criticised the comparative estimates submitted by the Board of Expert Engineers in their report upon Proposed Hudson River Bridges; and *Engineering News* (Sept. 13) in its customary able way of doing such work, has printed an excellent abstract of the letter. It is a well-known fact that engineers were not unanimous in approval of the report in question; and many of them will be inclined to side with Mr. Hildenbrand in the controversy thus opened, though perhaps not agreeing with him on all points. The criticism relates more especially to the "figures for weights, condition of loading, and price of material."

While conceding the general fairness of treatment of the subjects of the report, Mr. Hildenbrand makes the contention that the report has exaggerated the weights, put dimensions above what is actually required, and, to quote our contemporary, "assumed more severe conditions for live load and working stresses for the suspension bridge than for the cantilever."

It is asserted that the board itself acknowledged that it had assumed prices which were too high, evidently with the object of keeping on the safe side. Many have been impressed with the extremely cautious and conservative tone that pervades the report.

Viewed in the light of the maximum cost of a suspension bridge, no comment would be necessary, says Mr. Hildenbrand; but as a comparative estimate between two structures, one of which was estimated from previous careful and time-absorbing calculations, it is only fair that that structure should have the benefit of all possible accuracy, and acknowledged existing favorable facts should be fully considered.

When it is here added that Mr. Hildenbrand has gone over the calculations with due consideration of the modifications suggested in the report, and that in computing the weight of the stiffening truss of the suspension bridge, for the part of the load which it actually distributes, instead of computing it as distributing the entire load as is done in the report, he finds that the actually live load will be 15,000 pounds per lineal foot instead of 18,000 pounds, and that the cost of the bridge would be $2,634,000 less than the report estimates it; and when it is further stated that the letter from which the abstract is made has been submitted to the Secretary of War by the New York Chamber of Commerce, the importance of the criticism will be comprehended. But something more must be said to give an adequate idea of the force of Mr. Hildenbrand's criticism. After going over the data necessary to a final computation and comparison of cost, for which the article must be itself consulted, he arrives at the following conclusions: "The heaviest 3200-foot suspension bridge would cost only $2,600,000 more than the 2000-foot cantilever, and a lighter 3200-foot span suspension bridge fully safe and practicable could be built for $2,000,000 less than the 2000-foot cantilever bridge."

The Waterway from Chicago to the Gulf.

THE September number of *Milling* discusses what it regards as "the most important public work now being executed in the world," under the title "The Waterway from Chicago to the Gulf via the Illinois and Mississippi rivers." The article is prompted by the September excursion of the Western Society of Engineers to the work on the canal, the guests including a representative of the magazine named. After describing the personnel of the party

and other interesting details of the excursion, the article proceeds to give some interesting particulars of the work itself. It states that the work has gone steadily on, notwithstanding the panic and social disorder which has paralyzed business both east and west. It lays down as a proposition with reference to "all further canal construction" that "railroads cannot compete with water-carriage in hulls of 1000 tons or over. That is the limit of their economic endurance. In no instance have railways won against deep interior waterways. The day of small trunk canals is over; that of deep wide channels is recognized."

The writer alludes to the fact that "Canada has so far led the United States in waterway construction. "In time of war it would be feasible for Great Britain through the canals of this progressive province to put upon the lakes naval forces which we have not the conditions to meet; but when this Chicago work is completed, without violation of existing treaties the United States will be enabled to more than offset the very large advantage which Canada now possesses."

Reference is made to the effects upon sanitation of inland towns situated along the projected canal, and the writer says that this has been a source of constant solicitude. He holds, however, that there is no other solution to the drainage problem for Chicago. With reference to St. Louis and other interior towns the author thinks that the great constant current from Lake Michigan will alleviate the effect of constant growth of cities and towns draining into the Desplaines and Illinois rivers upon the potability of their waters.

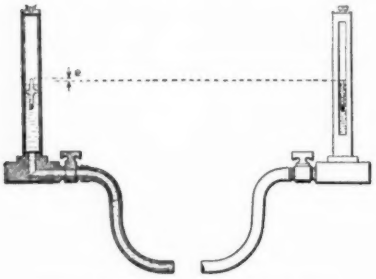
The economical advantages to Chicago and the people along the sixteen hundred miles to the Gulf from the construction of the canal will be incalculable. General Poe, in charge of the twenty-foot waterway improvement of the lakes, is authority for the statement that the saving to the public in 1890 alone was $135,000,000—two-thirds of all the expenditures of the government upon rivers and harbors up to date. Water-carriage adds but six and a half per cent. to the average value of goods, while railway freightage adds forty-five per cent. Who can doubt that this explains the enormous relative increase of wealth and population of deep lake ports—over Cincinnati, Louisville, St. Louis and New Orleans? A fourteen-foot waterway to the Gulf, if it follows the precedent of lake development, will be lined with manufacturing towns, supplying the wants of near consumers. The South especially will receive a commercial impetus. The increased demand upon her forests alone will bring hundreds of cargoes of lumber and ties yearly to Northern markets.

An anticipation of the effects which will result from the opening of this new avenue of communication is the topic of a very interesting concluding paragraph. Among these the impulse to ship-building and the increase of national security "through the adding of our lake ship-yard plants to those of the coast for the building and repairing of armed vessels" are among the most important, and the writer thinks the new route by way of the Gulf will become a strong competitor in the hands of lake ship-owners for much of the grain and provisions now transported by way of the St. Lawrence and the Erie canal.

Instruments for Testin Bridges.

AN excellent abstract of an interesting paper read at a meeting of the Verein fur Eisenbahnkunde, by Mr. Leschinsky, which treated of the present status of instruments for testing bridges, was printed in the *Railway Gazette* (Sept. 28). This abstract starts with mention of the difference of opinion among engineers relative to the life of well cared for bridges, and the statement that "the great cost of iron bridges renders it important to determine as exactly as possible when a structure ought to be rebuilt." Various methods and instruments for determining deflection are then noticed. A frequently employed but inaccurate method is described. "A piece of paper on a board is fastened to the truss in the center. Against it is placed the point of a pencil stuck through a vertical plank alongside, and the point describes a vertical line on the paper when the bridge deflects under load." An improvement upon this method is then mentioned which does not,

however, secure the desired accuracy. Other methods named are the use of a revolving paper cylinder upon which tracings indicating deflections are produced, and the use of a wire fastened to a sufficiently heavy weight and running over a sheave that moves an index over a graduated sector. The faults which are met with in the use of these appliances are stated to arise from a variety of causes, which are named. The Wienhold, and the Fuchs apparatuses are then described, and the causes of inac-



SEIBT'S BRIDGE TESTING APPARATUS.

curacies in their use are pointed out. Many important points relating to what is needed in testing the safety of bridges are alluded to, and the requisites of an apparatus for this purpose are summed up as follows:

"A thoroughly suitable instrument would have to fulfill about the following requirements: It must be simple and, if possible, without adjusting screws. It must be applicable without difficulty on all large and small, old and new bridges. It must be for the determination of the deformation of a chord, and also the changes of levels of all panel points with and without loading the bridge. The measurements must be possible without a staging, and must allow checking of results."

The apparatus of Dr. Seibt which is alleged to meet all the required conditions is then illustrated and described. For the purposes of this review the cuts illustrating the text were loaned by the paper quoted. The apparatus and the manner of using it, are thus described:

"It consists of two vertical glass tubes, connected by a thick rubber hose of ½ inch diameter and 52 feet length, the tubes partly filled with distilled water. In each tube is a float of black glass weighted with quicksilver. The elevation of the floats is read by means of a slotted and graduated tube slipped over the water tubes, on which slides a sleeve vernier. The top of the slot in the sleeve and the top of the float are adjusted to the same elevation which is then read. The two floats do not sink equally deep into the water. To ascertain the error it

FIG. 2.

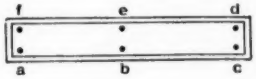


FIG. 3.

serves that the shoulder of the base of the glass tube on which rests the measuring tube has exactly the same elevation over the foot plate of each instrument. The difference of reading will give the constant error when both instruments rest on a level, horizontal surface. The instrument is used as follows: To the main trusses are fastened shallow cylinders, Figure 2, about 40 feet between centers. The cylinders have two studs which fit into recesses in the base plates of the tubes, thus preventing them from sliding off. Leveling from cylinder to cylinder along one truss and back by the other to the starting point, that is, from a to b, c, d, e, f, Figure 3 letting always the same glass precede, the test of correctness can be made by subtracting the sums of readings of one glass from that of the other glass. The difference must be zero, considering the index error e, which has to be multiplied by the number of readings. The accurateness of this instrument is 1-250 of an inch."

Ship-Canals, Ancient and Modern.

THE history of ship-canals, rather than the principles involved in their construction and operation, and their constructive details, is given in an article printed in *Western America*. The article has been written from materials accessible in encyclopædias and historical records, with added information collected from more recent engineering publications relating to ship-canals now in process of construction or projected.

The writer (the article is unsigned) claims that Americans do not appreciate the advantages of ship-canals, as commercial routes, as much as Europeans. If this

be so, the greater number of natural waterways available for navigation on this continent might well account for the fact, since up to the present time these, together with our great railway systems, have afforded enormous facilities for transportation of products.

The history of ship-canals dates back to the Pharaohs of Egypt, in whose time, and subsequently by Ptolemy, an unsuccessful attempt was made to connect the Red Sea with the river Nile by a canal large enough for the passage of ships of the period. The author then gives successively, brief accounts of ship-canals, from the first successful one known to history down to the present time; the latest completed work of this kind being the lock-canal which gives access to the city of Manchester for large ships, thus practically converting this city into a seaport town, and which is considered as the greatest engineering work ever undertaken in the United Kingdom.

This canal commences at Eastham, a small town near Liverpool, and runs 35½ miles to Manchester, with a minimum depth of 26 feet, and breadth of 120 feet at the bottom. All rail and highway crossings are at a minimum height of 75 feet above the canal. There are five sets of locks with a total lift of 60.5 feet. The entire cost of the work, which was opened for traffic during the early part of this year, amounted to upwards of $70,000,000.

Other ship-canals enumerated in this historical résumé are the Corinthian canal, cutting the Isthmus of Corinth, the first canal large enough to admit passage of war galleys, plans for which were caused to be drawn by Nero; the Fossa Drusiana, connecting the lower Rhine with the Zuyder Zee, 12 B. C., built by Claudius Nero; North Sea-Baltic Canal, across the Danish peninsula, a German work; Amsterdam ship-canal; the Clyde, which, though originally a small stream, has been deepened and widened to allow the passage of the largest ships into the heart of the city of Glasgow, the effect of which has been to raise Glasgow to the rank of the second city in the Kingdom, and convert it into the greatest ship-building emporium in the world; the canal that, when finished, will connect the Adriatic and Tyrrhenian seas; the canal projected by France for connecting the Mediterranean and the Atlantic ocean; the Chesapeake and Delaware canal across the Maryland Peninsula, and the Sault Sainte Marie canal, or "Soo," as it is generally called.

The article is, however, by no meaas comprehensive. No mention is made of some important works completed, projected, or in progress; such as the great Suez canal, the projects and attempts to connect the Atlantic and Pacific oceans by cutting through the isthmus joining North and South America at different points, etc.; it contains, nevertheless, information that will be new to many readers. The reconstruction of the old Corinthian canal, that has long been in ruins, and which is named above as the first successful ship-canal constructed, and which has lain in ruins for centuries, is spoken of as follows:

"A great work that is steadily going forward is the enlarging and deepening of the old Corinthian canal. In 1881 Gen. Turr obtained a concession from the Greek government, and work was commenced in 1882. The new canal is to be four miles long,—an almost straight line across the Isthmus of Corinth, and with an average depth of 26 feet."

A Proposed Ship-Canal.

A CORRESPONDENT of the *Scientific American*, Mr. Irving Boardman, propounds a scheme for a ship-canal to connect the Hudson river and the great lakes, which he justly thinks has much to recommend it, as necessitating fewer locks, passing the summit at the lowest point, and as being the shortest practicable line on which such a canal could be constructed. He states the length of this line to be 166 miles, or thirty-three miles shorter than that proposed by Mr. McAlpine to the Oswego board of trade several years ago.

Our plan is substantially this: Make Lake Oneida the summit and use it as our summit reservoir, and enter the Hudson near Albany, or rather south of it, near where the Delaware and Hudson railroad curves to the west. The sec-

tion extending from the Hudson inland would join the Erie canal at or near Schenectady, and would be as straight as it could be made, the distance being between these points sixteen or seventeen miles, instead of thirty, as at present by way of West Troy and the Erie canal. From Schenectady the line would follow the Erie canal to Utica. Thence a straight cut would be made to Lake Oneida, from the western end of which the canal would be excavated to Lake Ontario, joining it at or near Oswego. We avoid crossing the Mohawk by keeping to the south of it. We avoid locking up sixty or seventy feet going east from Lake Oneida, as in Mr. McAlpine's plan, by deep excavations from Little Falls, or near there to the lake, and passing beneath the "long level" of the Erie canal from sixty to eighty feet. The rise from the Hudson to Schenectady being about 200 feet, would necessitate twenty locks, and about the same number would be required from there to the point where we would reach our long level at Little Falls or near there, to and through Lake Oneida to the first lock beyond, a distance of from sixty to seventy miles. There would be needed six or seven locks between Lake Oneida and Lake Ontario. The present outlet of Lake Oneida would be closed and Oswego river would be left alone, except to feed the canal. At the points where the canal enters and leaves the lake, gates would be placed to accommodate the varying height of the water. Oswego harbor would require deepening to accommodate boats of twenty feet draught, provided our canal passed boats of that size. The prism of the proposed canal would be large enough to pass any boat that could pass the Welland canal.

He thinks the supply of water for the needs of the canal would be satisfactorily settled by this plan, as Oneida lake would supply water to pass the summit both ways. The demands west of the lake he thinks would be met by Oswego river, and east by the Mohawk river. The writer thinks this is really the only practical route for such a canal, and argues for its feasibility, though as to its cost he admits that he has made no estimate. There are points made in the scheme worth considering, though it may be that a thorough survey would develop impracticabilities not anticipated by Mr. Boardman. He admits there would need to be some very heavy excavation; but thinks none greater, or at most but little greater, than was done on the Suez canal would be required. The author alludes to the obvious advantages from having such a canal entirely within the United States. In such case the depth of the canal could be regulated to allow the passage of any vessel drawing fourteen feet, and it is stated that the bulk of ocean freight is carried in vessels drawing no more than this.

The Alignment of Tunnels.

THE important and at times difficult process of aligning different sections of tunnels in railway construction is treated editorially in *The Engineer*. The discussion is opened pleasantly by recalling a story with which tyros in engineers' offices are often entertained. This relates to a mythical tunnel of indefinite location where headings "were carried past one another instead of meeting." The story is that the mistake was discovered through the circumstance that the gang working in one heading knocked off work for dinner a little earlier than the other, and the sound of their implements ceasing, the sound of those of the men who continued working was noticed to come from the side instead of the front, thus leading to an investigation that revealed the fault. Quoting the remarks of the President of the Institution of Civil Engineers, the editorial goes on to say that since the time of the memorable occurrence narrated, which appears to have been assigned in turn to nearly every tunnel that has been constructed, "better methods of setting out tunnels have been introduced." The writer then classes the setting out or alignment of a tunnel under three heads. "First, the ranging or alignment above ground; secondly, that below, either in the heading or in the full section of the tunnel; and, thirdly, what may be called the vertical alignment, or, the transference of the surface-line to the subterranean one."

Should the tunnel, similar to the longest two existing at Mont Cenis and Mont St. Gothard, be constructed without shafts the vertical alignment is not required, as presumably the tunnel would be ranged from points observed directly from each extremity. In other words, the line

of direction being given by the fixation of a couple of terminal points at any visible distance from the ends of the tunnel, the alignment may be obtained by setting up the instrument, whether a plain transit or a theodolite, over the nearest point, sighting backwards, reversing and ranging forward, or by absolutely ranging the line backwards from the fixed points. It is extremely rare that contours of the ground beneath which the tunnel is situated are sufficiently favorable to allow of one extremity being visible from the other; that is, to permit of the total length being ranged forward in either one direction or the other. The more general case is that in which, while the ends of the tunnel themselves are not sightable the one from the other, yet a summit level obtains from which as a common point, even if, as frequently occurs, the ends are not visible, points in the direction of the line of trace can be accurately determined, marked, and rendered available for the alignment of the face headings or driftways. The distance at which these points are located from the mouths of the tunnel will depend upon the physical features of the surface, but it is really a matter of little moment how far off they may be situated, so long as they are fairly within the range of the instrument employed. With this proviso, the farther off they are the better, as they admit of a more accurate and delicate adjustment by the cross wires of the telescope.

The tunnels on the Dore and Chinley Railway, were aligned by a forward and backward sighting from a summit level. Very interesting particulars of this alignment are given, and methods employed on other large tunnels are reviewed, making the article, as a whole, especially valuable to students of engineering. Statements of the amount of deviation that resulted in the execution of the work of some of the most notable tunnels, as given in the article, are as follows:

The total deviation of the headings in the Totley tunnel was 4½ inches in every 555 yards of heading, a very satisfactory result. In the Mont Cenis tunnel, which is shaftless, the horizontal deviation is given as *nil*. But in the similar work at Mont St. Gothard, the total error amounted to 13 inches, or 1 inch in every 627 yards, assuming the "thirl" to have taken place at about midway. In instituting this comparison, some additional credit may be fairly given to the St. Gothard tunnel, having regard to its great length, which closely approximates to 9¼ miles.

Diagram for Wooden Beams and Posts.

Two diagrams for use in engineers' and architects' offices in proportioning wooden beams and posts, are given on an inset sheet by *Engineering News* (Sept. 27). These diagrams were devised by Mr. Carl S. Fogh, C. E., of Denver, Col. The paper quoted regards these diagrams as excellent examples of the rapidity and freedom from error with which computations may be made by the graphical method. Such helps are among the most valuable of contributions to technical literature. *Engineering News* says of these diagrams that they were first computed and platted on a large scale by Mr. Fogh, and then reduced for the inset sheet by photo-lithography. It is therefore believed that their accuracy may be relied upon. The principles upon which the diagrams are constructed, and full explanations of their use are given in the accompanying text, and a little study will give facility in their use. A practical trial of the method made with a view to test its value, proved that a great deal of time can be saved by the use of this diagram, while at the same time as accurate results are obtainable as any one could wish for practicable purposes.

Something may be said here with propriety upon the value of the graphical method in making such computations, which, by the way, is now being actively discussed in engineering and mechanical publications. While as time saving devices they are worthy of the highest commendation, they by no means obviate the necessity for an engineer to be an expert mathematician. Some papers appear to have placed such an exaggerated estimate upon graphic methods as to lead one to the belief that they think these will almost supersede mathematical methods. Only those not fully conversant with the resources which mathematical skill confers upon its possessor could possibly entertain such an opinion. At the same time it is undoubtedly true that where simple graphical methods can be devised, a liability to err which besets inexpert computers is removed. Hence such methods are becoming more and more popular, and new ones are constantly appearing.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Bridges.

25044. A Criticism of the Experts' Estimates of Cost of a North River Bridge. W. Hildenbrand (E N-Sept. 13.) 1200 w.

*25119. The Pecos Viaduct. Ill. Julius Kruttschnitt (E A S-Aug.) 2800 w.

*25124. The Sher Shah Bridge, Punjab, India. Ill. (E-Sept. 7.) 2000 w.

25165. Construction of the Granite Viaduct. Ill. (E R-Sept. 15.) 1300 w.

25290. The Wallabout Canal Drawbridge. Ill. (E R-Sept. 22.) 1000 w.

25405. Notes on Instruments for Testing Bridges. Ill. (R G-Sept. 28.) 1200 w.

*25449. Road Bridge for Brazil. Ill. (Eng L-Sept. 21.) 3400 w.

Canals, Rivers and Harbors.

24965. Ship Canals, Ancient and Modern (W A-Sept.) 1800 w.

25045. The Proposed Ship Canal Across New Jersey (E N-Sept. 13.) 4800 w.

*25140. The Manchester Ship Canal. John Dean (J A E S-Aug.) 5500 w.

25204. The Nicaragua Canal. Chauncey F. Black (M R-Sept. 21.) 2800 w.

25232. The Anti-Canal Convention. Editorial (Sea-Sept. 20.) 1200 w.

*25261. The Panama Canal—"To Be or Not to Be?" (Ry T-Sept. 15.) 1000 w.

25391. The Deep Water-ways Convention, with Editorial (Sea-Sept. 27.) 3800 w.

*25521. The Waterway from Chicago to the Gulf via the Illinois and Mississippi Rivers. Ill. (Mill-Sept.) 2500 w.

25542. A Proposed Ship Canal. Irving Boardman (Sc A-Sept. 29.) 800 w.

†25546. Notes on the Improvement of Philadelphia Harbor. L. Y. Schermerhorn, with Discussion (P E C P-April-June.) 6000 w.

25633. Water-Power Canal for the Niagara Power and Development Company. Ill. (E N-Oct. 4.) 700 w.

Hydraulics.

25029.—$1.50. The Cippoletti Trapezoidal Weir. Ill. A. D. Flinn and C. W. D. Dyer (T C E-July.) 6000 w.

*25448. Glasgow Weirs. Ill. (Eng L-Sept. 21.) 3300 w.

†25543. The Baptism of the Great Niagara Tunnel. Emile Geyelin (P E C P-April-June.) 3000 w.

25564. Calculations for the Flow of Water in Pipes Simplified. William Cox (A M-Oct. 4.) 800 w.

25586. A Bird's-Eye View of Niagara Falls. Interesting Data of This Tremendous Water Power. Ill. (E R N Y-Oct. 3.) 750 w.

25627. Machinery for Operating a 247-ft. Swing Span by a Pelton Wheel. Ill. (E N-Oct. 4.) 800 w.

25654. Limits to the Profitable Development of Water-Power (E N-Oct. 4.) 3000 w.

Irrigation.

24967. A Review of Irrigation.—Lessons to Be Learned. Ill. J. W. Powell (W A-Sept.) 2800 w.

24968. Irrigation—Theory and Practice. B. C. Buffum (W A-Sept.) 2400 w.

†25024. Inundation Canals. E. A. S. (I E-Aug. 11.) 2000 w.

25047. The Cession of Arid Lands to the States (E N-Sept. 13.) 500 w.

*25137. The West Gallatin Irrigation Canal Montana. Ill. A. E. Cumming (J A E S-Aug.) 3000 w,

†25360. Irrigation in the Native States of the Malay Peninsula (I E-Aug. 25.) 1500 w.

*25560. The Progress of Irrigation Thought in the West. William E. Smythe (R of R-Oct.) 3700 w.

Miscellany.

*24954. Advantages of the Tehuantepec Route. Ill. Elmer L. Corthell (E Mag-Nov.) 3000 w.

*24921. The Alignment of Tunnels. Editorial (Eng L-Aug. 31.) 2000 w.

25054. Asphaltic Cement. A. S. Cooper (Sc A S-Sept. 15.) 3500 w.

*25139. Masonry Lining at Mullan Tunnel. Ill. H. C. Relf (J A E S-Aug.) 2300 w.

25409. Diagrams for Proportioning Wooden Beams and Posts. Ill. (E N-Sept. 27.) 400 w.

25410. The Busk Tunnel on the Colorado Midland R. R. Ill. (E N-Sept. 27.) 1600 w.

*25514. The Philadelphia Asphalt Tests. Dolphus Torrey (P-Oct.) 1200 w.

*25682. Solid Rock Dredger. Ill. (Eng L-Sept. 28.) 1800 w.

Serials.

21592. The Harlem River Speedway. Ill. (E R-Began April 28—9 parts to date—15 cts. each).

22758. The Chicago Drainage Canal (R R-Began June 9—15 parts to date—15 cts. each).

23669. Centrifugal Pumps. Ill. John Richards (I S F-Began July—4 parts to date—30 cts. each).

24421. Notes on the Strength of Framed Structures as Affected by Elasticity. C. F. Findlay (Eng L-Began Aug. 10—Ended Sept. 7—3 parts—30 cts. each).

25445. The Clyde Trust Dredger "Cairndhu" Ill. (E-Began Sept. 21—1 part to date—30 cts).

25661. Module Gate. Ill. R. G. Kennedy (I E-Began Sept. 1—1 part to date—45 cts).

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Sanitary Plumbing.

A MOST important point as regards the relation of contracting plumbers to work executed by them is brought to public attention in an article printed in *The Architect* (London). The writer of this article claims to speak from experience when he says that the terrible havoc made from time to time through the agency of defective plumbing-work in Great Britain and America has, without proper inquiry, been attributed to plumbers, forgetting or ignoring the fact that for the most part plumbers' work is issued in accordance with specifications "which, in the majority of cases, were framed on false economy and very often in ignorance of the subject by the architect who drew them."

The article is a reprint of a paper read before the Associated Master Plumbers of Victoria by M. F. B. Brady, and first printed in the *Australasian Builder*.

"As a sample, an architect specified (where the owner would willingly pay for good work) a 4½ inch cast-iron rain-water pipe with red lead joints for vertical soil pipe from three water-closets; and to make matters worse, had it fixed in a recess in a wall. When remonstrated with, he said: 'Carry out the work as specified and I will accept all responsibility.' I merely mention this as an instance of how the plumber is blamed for defective work when the specifications distinctly give him material to use which renders it impossible to make the work secure for any length of time; and then the architect is the first to fix the blame on the plumber. I sincerely trust for the sake of all concerned that the architects of this colony will have all fixed rules and data at their fingers' end, so that incompetent and unscrupulous persons may be prevented from undertaking the execution of work which they do not understand. I consider that every architect should be sufficiently instructed in plumbing to know the difference between good and bad work in course of construction, not after."

The paper is a long one, and goes over the whole ground of materials and workmanship. With reference to protecting cast-iron soil pipes Mr. Brady says, that, while some good authorities advocate first galvanizing, and then coating with Dr. Angus Smith's solution, the unenduring character of all solutions is well known. "Although the idea looks well on paper, in a great many cases it helps to cover defects and imperfections which might exist in the pipe." From his practical experience he doubts very much the efficacy of any solution when applied to soil pipes.

"I do not for a moment dispute its qualities as a temporary resisting medium to oxidation in iron pipes, when used as a conduit for fresh water. I am at a loss to know why such good authorities prefer that cast-iron pipe should be galvanized when used for soil pipe. I am sure it requires no great reasoning to prove that the use of zinc should be studiously avoided and condemned, and no architect or plumber should allow it to be used. Now as to incrustation, I have taken down some cast-iron soil pipes which have been in use for about eight years. When I examined the amount of deposit on one side of the pipes, especially at the joints, it seemed incredible; but wherever the incrustation was greatest the pipe was perfect, although one could crush the opposite side with the fingers. No doubt the deposit formed a concrete, and protected the surface covered at the expense of the other side. I might mention that it was a medium description of a cast-iron pipe, ventilated, but improperly. At a recent convention of the Master Plumbers of New York, a section of iron soil pipe taken from a building was exhibited. The exhibit showed in a practical way the ravages made on iron pipe which was fixed, yet at the same time appeared to be in a fair state of preservation, with the exception of a deposit of rust. If required I could give several instances like the foregoing with date and place."

The author advocates the use of iron for soil pipes. He is certain it will be largely used in Melbourne in future work. As a drain pipe he would compel it to be used in all cases where passing through or under a house; for, buried in the earth, it

would be free from destructive atmospheric influences; but he strongly deprecates the use of galvanized cast or wrought iron pipes for soil or waste pipes, even when disconnected from the drain. As to lead soil pipes he says:

"Now as to lead soil pipes, I have often read and heard a great deal about the incrustation on them, but in my experience I have failed to discover anything approaching the incrustation previously described as existing in the iron pipe, even when fixed under much more unfavorable conditions, viz., no ventilation. One proof of this statement: During a building alteration in the Mercy Hospital, Cork, 1881, I had to remove a stack of 4½ inch lead soil pipe which had been in position for over thirty years and was not ventilated. I was astonished at the state of preservation of the lead; the only portion that looked suspicious was the soldered seam. I cut the seam out, left the lead to dry, and when I again examined it found no sign of deposit except a small powdered substance. But the lead traps, especially the seal chamber and above it, when touched, actually fell asunder, being completely oxidized. Still I do not doubt there have been such cases of incrustation in lead soil pipes met with, but I have never seen them."

The Difference in Amount of Radiation Required in Buildings of Good and Poor Construction.

As bearing upon the recently agitated question of guarantees, given by heating contractors to owners, or, as a well-known writer has recently put it, "how far the risks of failure to heat a building ought to be shared between the owner and contractor," a paper read by Mr. E. P. Bates of Syracuse, N. Y., at the sixth annual convention of the Steam and Hot Water Fitters' Association of the United States, held in New York city in June, 1894, is very instructive.

The paper gives an account of personal experiences as a contractor in this line of business, and indicates that failure to heat buildings to a guaranteed degree in "zero weather" is often much more the fault of the constructor of a building than of the contractor who puts in the heating plant. This being admitted, it has been held by another writer on the subject, that guarantees should be mutual, and that the guarantee of the contractor that the apparatus he places in a building will heat it to a stated degree under stated conditions, shall include among those conditions that the building shall be well constructed, whether it be of stone, brick or wood. Only one interesting example given by Mr. Bates will be here quoted out of a number of equal significance.

In the fall of 1879, I placed a low pressure steam heating apparatus in a building designed for a home for old ladies. Many of the rooms were small, and in order to warm them without question a radiator was placed in each room. Knowing that a high temperature would be agreeable, the calculation was made that one foot of radiation would warm forty cubic feet of air. This we considered very liberal when the fact that we used the Gold sheet iron radiator is taken into account. We were, however, doomed to a very serious disappointment, as the temperature in the room on the windward side of the house frequently fell to 50° and sometimes even below during severe cold and windy weather. After reconsidering all the conditions we determined to add a large percentage of radiation, which was done, and the building has been thoroughly warm ever since. The amount of radiation added in many of the exposed rooms was from 50 to 100 per cent. over that originally supplied. To my mind the rooms in this building are very uncomfortable; for the excessive amount of radiation required to maintain the temperature produces a very disagreeable condition of affairs, together with the excessive loss of heat through the thin walls and many air leaks. It was soon found that, although the ratio of radiation was very excessive, under the existing conditions the condensation was very rapid, and more boiler power was required to maintain the steam pressure. Consequently an additional boiler was supplied at the expense of the heating contractor, which gave plenty of generating power, but all this was accomplished at a heavy proportional loss to the contractor. To my mind, as I review the entire matter, I find that the original calculations for boiler and radiating surface were correct, providing the building in question had been ordinarily well constructed. But from subsequent surveys I conclude that the architect and building contractor produced about as poor a specimen as it was possible to do and have it stand up as a public building. The result is that the amount of fuel needed to warm the building is enormous.

The example well illustrates the risks which contractors take in giving the customary guarantees; and as in many cases it is impossible for them to determine when making their estimates whether the building they are estimating for will be well built or otherwise, it seems unfair that all this risk should be borne by the contractor alone. The heating trade has already begun to protest against this injustice.

Irrigation of City Parks.

THE burden of an editorial article in *Garden and Forest* upon the subject indicated in the title, is the need of appliances for irrigating public parks. Much of what is said upon the subject also applies so well to private pleasure grounds as to fitly find a place in Domestic Engineering.

The position is taken that "no city park ought to be called finished until adequate provision is made for watering every inch of it."

Unfortunately there are very few public or private parks in this country that in time of drought can so effectually irrigate as to prevent injury to any part of the grounds. The article quoted cites Central Park, New York, as an exampleof miserable deficiency in means for irrigation, and says it should have an addition of from thirty to forty thousand feet of underground piping, and fifteen to twenty thousand feet of rubber hose to supplement its present facilities for watering the grounds in dry weather. Of New York city parks it says:

As an evidence of the beneficent effects of irrigation one has only to glance at the chain of small parks in Fourth Avenue, where the shrubs are holding all their leaves, and the grass is a vivid green even on the thin soil of the tunnel. On the other hand, Morningside Park is a picture of desolation which it is painful to behold. A feeble attempt at watering the lower portion of this park has been made by attaching hose to one of the city hydrants far beyond the limits of the park, and last week we saw several men doing the best they could with a reach of hose a thousand feet long. But this is slow and ineffectual work, and it is a wonder that any of the shrubs on the rocky slopes are alive.

With reference to increased facilities for irrigation it says:

With such a plant a very small force, working systematically, could do effectively what four times as many men are now trying to do and making an utter failure. It is easy to see how large an area one man could attend to regularly and systematically if he had the proper machinery, and how in this way a perfect record could be kept, showing just when a space had been watered, and just how much was given to it. There may have been some excuse for dribbling out an inadequate water-supply to the parks when water was said to be scarce, although there seems no reason why the city should not deal with the parks in this respect as liberally as with any similar area in its thickly populated portions. There is no lack of water now, however, and there is no one thing that Central Park and Morningside need so much as proper facilities for applying it.

Slipshod Sanitation.

IN one of the Manchester (England) Health Lectures, Dr. Noble questions why it is that in spite of the great amount of work done in recent times for the advancement of sanitary measures there has not been a corresponding decrease of sickness and of the death-rate. In the *Plumber and Decorator* (Sept. 1, 1894), W. L. Hunter, M. D., answers the question in a way that applies to American as well as to English cities. He alleges that a large portion of what is called sanitary work in city dwellings is such simply in name, and that from various causes, sanitary laws are not properly enforced.

Personal habits of diet and drink, and attention to, or neglect of personal cleanliness, have much to do with the sanitary condition of towns especially among the poorer classes; but Dr. Hunter holds that ineffective administration of sanitary regulations is the main factor in keeping death-rates up to their present mark.

Much worse than the passing of these permissive Acts is the fact that the compulsory Acts are only compulsory in theory, and, as a fact, they are to a great extent disregarded. It is a matter of daily knowledge that a great portion of what has been called the Sanitary Charter, the

Public Health Act, 1875, is allowed to be a dead letter, and is ignored by the guardians of the public health.

An example of the loose administration of sanitary laws is found in the way vaccination is resisted and evaded.

Of this he remarks: "In some places the act is not enforced at all, and in others the one-mark, or what the Yankees would call the "one horse" system of vaccination is steadily on the increase."

As a reason for not enforcing sanitary laws, it is alleged that the public are not sufficiently educated to understand the importance of them. This seems to me rather an argument for giving effect to them. If there is any doubt about the good of a measure I can understand waiting for the development of public education; but when its utility is so fully established, there can be little objection to strictly enforcing it. The "liberty of the subject" bugbear is another plea. This cuts both ways, and it is against reason that a man should be allowed to commit manslaughter by poisoning his neighbor's family with infectious disease, or with sewer gas from his defective drains. Besides, this same delicacy for private feeling is not shown so strongly in other matters, *e. g.*, in the collecting of rates and taxes, or in the stamping out of cattle diseases. These inefficient laws are frequently made less effective by the conditions under which they are administered.

The article goes on to point out glaring evasions of sanitary regulations in drainage of English dwellings, illustrating defects by engravings which fully justify the term "slipshod" adopted in the title of the paper, and would seem to justify even a stronger term, had the author wished to be sensational in his treatment of the subject. A large number of examples are thus treated. One only will be mentioned in this review,—a school in which the soil pipe "was connected without a trap to an offensive rubble sewer," and the whole of the drainage work was so defective that the soil for some distance around them was impregnated with foul discharges. Rain water pipes were directly connected with this drain, and four of them had openings just below and about six inches from where the school windows were opened to admit fresh air, no special means of ventilation having been provided.

Specification Writing.

IN a series of articles printed in the *American Architect* entitled "Specification Writing," the whole being a lecture on this important subject delivered before the Architectural Department of the University of Pennsylvania, by Mr. T. Roney Williamson, architect, the following maxim relating to architects' specifications, which, indeed, applies equally to all specification writing, is given.

"Make your paths straight so that the wayfaring man though a fool, shall not err therein, but make them narrow as well, so that he shall have no room to wabble."

This series of articles is indexed appropriately in our department of architecture; but in the second number of the series there is a scheme for plumbers' specifications which may be of use to plumbers not only in preparing specifications for themselves, as they sometimes do, but also as expressing the views of an accomplished professional architect as to what a complete specification for plumbing ought to comprise.

A PAPER on "Diseases Occasioned by Emanations from Sewer Drains, Cesspools, and other Organic Refuse," written by Dr. Mark Jackson, of Barnstaple, England, and read at the meeting of the sanitary inspectors of that town, is well worth the perusal of all who, either as members of health-boards or as sanitary inspectors, or as general readers desire information upon the subject. The remarks upon what Sir John Simon many years ago styled "preventible diseases," to which Dr. Jackson attributes one-quarter of all the mortality in England, is of especial interest. The paper is printed in full, in *The Sanitary Record* (Sept. 8).

With regard to pyœmia and erysipelas, it must suffice to say that various outbreaks have been recorded, in which defects, of the kind already related, were found to exist, and on being remedied the illness ceased to occur. One other group of cases I should like to mention, viz., those affecting some of the internal organs, as the lungs, the kidneys, and possibly the brain. In 1888 Sir George Johnson published a series

of cases of kidney affection, which he believed to be due to the absorption of sewer poisons after carefully excluding all other causes. The most appropriate case from my point of view is the following: A town surveyor, aged forty-seven, had been ill for several months and was found to be suffering from kidney disease of a serious form. Asked how his illness began, he replied: "I have not been well since I got blood-poisoning, eighteen months ago. I was supeinrtending the opening and repair of a blocked drain, and the smell was so bad, I came home and vomited several times. Next day I went again to open the drain, and the smell immediately made me vomit. At first I suffered from disordered digestion, with headache and vomiting. I have never been well since." And the poor fellow never recovered. Another case cited by Sir G. Johnson was that of a schoolmaster living in the basement of a schoolhouse, where there was a blocked drain, the area in consequence being flooded after heavy rainfall. He developed kidney disease, although a teetotaler.

Numerous other cases of disease resulting from sewer poison are cited. A private school, situated on the outskirts of a town of about 7000 inhabitants, had a lawn in front, separating it by about 25 yards from the public road. One of the main drains of the district passed beneath the road, and a ventilating opening had been recently made into the drain, in spite of a protest from the proprietor of the school. At the time the sewer was opened the wind blew towards the house, carrying with it a most offensive odor. A few days after the drain had been opened, about one dozen cases of illness, more or less serious occurred amongst the boys and other inmates, among which were cases of pleuro-pneumonia, complicated with abscess.

INDEX TO LEADING ARTICLES.

The ournals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Heating and Ventilation.

25030.—$1.50. Tests of Condensation in Cast Iron Radiators. William J. Baldwin (T C E-July.) 1500 w.

25056. Air Velocity—Anemometer Measurements. Editorial (Met W-Sept. 15.) 1000 w.

25057. Heating Philadelphia County Prison. Ill. (Met W-Sept. 15.) 2500 w.

*25201. Some Points in Ventilation (J G L-Sept. 11.) 2500 w.

25221. Methods of Constructing Chimney Flues and Pipes at Paris. Ill. Arthur Vye Parminter (Sc A S-Sept. 22.) 1100 w.

25285. The Efficiency of Insensible Ventilation. James M. White (A A-Sept. 22.) 2600 w.

25293. Heating and Ventilation of the Royal Victoria Hospital at Montreal. Ill. (E R-Sept. 22.) 1400 w.

25581. Remodeled Heating Plant in a City Residence. Ill. (E R-Sept. 29.) 700 w.

Landscape Gardening.

24988. Irrigation in City Parks (G & F-Sept. 12.) 900 w.

25700. Landscape Art and Rural Architecture. William Webster (L A-Sept.) 1100 w.

25702. Lawn Decoration (L A-Sept.) 500 w.

Plumbing and Gas Fitting.

*25007. Petroleum or Gas for the People? Editorial (J G L-Sept. 4.) 1600 w.

*25026. Slipshod Sanitation. Ill. W. L. Hunter (Pl D-Sept.) 2200 w.

*25136. Sanitary Plumbing. F. B. Brady (A L-Sept. 7.) 3500 w.

25210. Lessons in Practical Plumbing—Altering Underflow Work. Ill. Grayson (S P-Sept. 15.) 1300 w.

25289. Gas Piping for Buildings (E R-Sept. 22.) 900 w.

25295. Essential Requirements for the Gas Piping of Buildings (E R-Sept. 22.) 700 w.

*25345. The Sanitary Association of Scotland (S R-Sept. 15.) 2000 w.

Miscellany.

*25118. Diseases Occasioned by Emanations from Sewer Drains, Cesspools, and Other Organic Refuse. Mark Jackson (S R-Sept. 8.) 3800 w.

*25239. Cesspools for Country Residences. Ill. E. S. Marsh (D E-Sept.) 1100 w.

25247. The Greenhouse (Met W-Sept. 22.) 800 w.

Serials.

24542. Plumbing in Mr. C. P. Huntington's Residence. Ill. (E R-Began Aug. 25—4 parts to date—15 cts. each).

24643. Protection from Lightning. Alex. McAdie (E E N Y-Began Aug. 29—4 parts to date—15 cts. each).

25500. The Gas Cook Stove as It Is and as It Should Be. Adam Gasmann (P A-Began Oct. 1—1 part to date—15 cts).

25660. Congress of Hygiene at Budapest (A & B-Began Oct. 6—1 part to date—15 cts).

25716. Power and Heating Plant, Manhattan Life Insurance Building. Ill. (E R-Began Oct. 6—1 part to date—15 cts).

We supply copies of these articles. See introductory.

ELECTRICITY

The Truth About Municipal Electric Lighting.

IF there is any one thing more than another respecting which it seems almost impossible to procure trustworthy data, it is the actual cost of operation in electric-lighting plants owned and managed by municipalities. Nowhere is it more true than in municipal bookkeeping, that although figures may never lie, liars are frequently permitted to figure. The *Electrical Engineer* has performed a real and lasting service to the public and to the profession. by giving in its issue of September 5, a series of carefully compiled tables exhibiting the results of a detailed and systematic inquiry into the workings of electric light plants in the United States under municipal management. This work has been done by Horatio A. Foster, a well-known expert in electrical industrial statistics, and may fairly be said to be a model investigation of its kind. More or less complete returns were received from 42 stations out of some 150 to which circulars of inquiry were sent. Of these, only 34 have given information admitting of complete tabulation. The inquiries relate to capital invested; cost of equipment; capacity of dynamos; operating expenses and fixed charges, with the necessary subdivisions of these general subjects. Fixed charges, *i. e.*, interest and depreciation, have been returned in but very few instances, and the deficiency has been supplied by the compiler from the best available data. In more than half of the 34 municipalities from which full reports have been received, the population is under 5000, rendering it extremely doubtful if a plant under any kind of management would be a profitable undertaking. All the items mentioned are worked out in the tables in great detail, but anything more than a brief summary of some of the most important deductions would exceed the space at disposal. The average cost of "full-arc" plants for city use is $249.30. This agrees very well with $250 per lamp, the price quoted formerly by a leading manufacturing company, and does not appear to sustain the contention that municipal plants are always more costly in the first instance than private ones. The cost of incandescent plants averages $258.91 per kilowatt, which does not seem to be excessive. A comparison of the unit cost per arc-lamp-hour in 14 municipal plants with the cost of the same in private plants, in cities of corresponding population as given in the census report of electrical industries in the state of New York, shows that the former is $0.0444, and the latter $0.0358, an economical difference of 20 per cent. in favor of the service supplied by private companies. One table given enables a comparison to be made between the total cost per kilowatt for the output of the station; the cost per kilowatt for city lighting after deducting the total income from the total gross cost, and the price per kilowatt to cities supplied by private companies. This table shows that the actual cost of electrical energy per kilowatt to a municipality, is greater when commercial lighting is furnished than when the city does its own lighting only, a fact which would seem to be explicable only upon the hypothesis of extremely low prices for commercial lighting. Mr. Foster has apparently taken the utmost pains to present the whole matter with perfect impartiality, and his results, so far as they go, may be regarded as more trustworthy by far than any figures heretofore given to the public. By way of a side-light on the question, it would be a pity not to quote part of a reply received from the manager of one municipal plant, which extract is herewith submitted without comment:

"The mayor and all councilmen, city clerk

and all citizens of the city try to run the plant. The waterworks and electric lights are run together. As the mayor and committee with the assistance of a leather-headed clerk all dictate what shall be done and where supplies shall be bought, I therefore have no report to make. With eight years experience, I would advise all towns to hire their lights which is by far the cheapest. After May 1st the plant may be more in a business way. I am not in favor of any town or city owning an electric-light plant."

It may fairly be contended that Mr. Foster's figures do not support the assertions so confidently made in many quarters as to the superior excellence and cheapness of the service furnished by municipally-owned plants. Still, it must be said, that while the municipal figures might be much better, the figures of many of the privately owned plants are no better than they ought to be. There is evidently a great opportunity for reform in the bookkeeping of American electric lighting stations, both public and private.

Driving Factories by Electricity.

GEORGE A. GOODWIN, president of the Society of Engineers, London, writing to the *Textile Recorder* of Manchester, makes some interesting observations in respect to the economy of electrically-driven machinery in factories, which are in part reproduced in the *Boston Journal of Commerce* (September 8). Mr. Goodwin points out that one inherent advantage in driving by electricity is that the conductors convey the power practically without loss and only in strict proportion to the demand, while in case of mechanical transmission the loss by friction is not only very considerable, but is a constant quantity, whether full or partial work is being done, amounting in many cases to as much as 20 to 40 per cent. of the gross power. The longer the distance of transmission and the less the load, the greater the proportionate loss; in many cases a very important matter. From the necessarily intermittent character of the work in factories and workshops, frequently only a small fraction of the work done by the engines is actually converted into useful effect at the machines. A further objection to the mechanical system is the almost insurmountable difficulty of economical extension; for instance, to increase a plant of 500 horse power to 700 or 800 horse power would require the almost complete substitution of heavier shafting, and a great augmentation of dead load on the structure, while in case of an electric installation, little or no radical alteration would generally be required. In factories where the machinery works intermittently and is liable to great fluctuations of load, the economy of working by electric power is very marked, as only a sufficient amount of current is required at any time to do the the work in hand. The current can be switched off and on with the greatest ease and rapidity, and in comparison, the use of cross-belts and loose pulleys appears to be a clumsy, not to say unscientific, method of handling power. Where each machine may have its own motor, a unique and highly economical method of using power is available. It is hardly necessary to remark that no hard and fast law can be laid down; each case must be individually considered, and that system adopted which promises the best results. In the case of existing works, it is probable that the cost of conversion to the electric system would seldom be warranted, but for new factories or renovations, without doubt the question of electric driving should be most seriously considered. In these days of fierce competition, when profits are reduced to their lowest ebb, the careful study of every possible means of economical working is of vital importance to every manufacturer.

The Earth as an Electrical Conductor.

THE discovery that it was practicable to make use of the earth as a return conductor for telegraphic currents was made by Steinheil as early as 1837. In all practical telegraphic work, for half a century past, the earth has been regarded and treated as a conductor of infinitely small resistance, although in some special cases this assumption has proved to be very far from the truth. In attempting to use the earth as the return for an electric-motor line 3000 feet long, at the Alabama Polytechnic

Institute some two years ago, the terrene resistance was found to be abnormally great, and an investigation of the matter was accordingly undertaken by Mr. John H. Holt, the results of which are embodied in a serial paper in the *Electrical World* (September 22, 29). Two sets of earth plates were used; one pair of copper of 14 square feet surface, packed in iron filings and charcoal and buried in moist earth, and the other pair of iron, 2½ by 3½ feet, immersed in the water of wells dug for the purpose. With a dynamo current, the resistance of the earth was found to increase with the strength of current, and it was also found that the resistance was much higher when the plates were immersed in water than when buried in the earth. In another experiment, using intermediate plates, it was found that the resistance of the first 500 feet was greater than that of the whole 3000. This paradoxical result proved to be due to the character of the geological formation, which was Laurentian overlaid with drift. The resistance of the drift proved to be very much higher than that of the older formation. The effects of polarization were very marked in some of the experiments. Eliminating these, the resistance of the earth between the terminal plates was found to be 92.4 ohms, and between the plates immersed in the wells 121 ohms; much more than would have been expected *a priori*.

How Incandescent Lamps Are Made.

AT the end of the year 1893, according to the most trustworthy statistics accessible, there were in use in the United States, in central-station plants, a total of 2,500,000 incandescent lamps, and in isolated plants nearly 1,500,000 more, making a grand total of no less than 4,000,000 lamps. In view of these figures it certainly seems remarkable that so little information has been published respecting the processes and methods actually in use in the lamp factories of this country, and it is perhaps no less remarkable that one of the best papers which has yet appeared on the subject should be found in a journal devoted to a rival—we had almost said a hostile—industry. In the *American Gas Light Journal* (September 24) William E. McKay gives a minute and well-illustrated description, covering nearly four large pages, of the processes employed, presumably in the Beacon company's Boston factory, of making incandescent lamps with silk filaments. The substance of this description, if not its very language, is confessedly borrowed from an address by Mr. E. E. Cary before the graduating class of the Massachusetts Institute of Technology last summer, but electrical engineers will probably be glad to get hold of it, even in this roundabout way. One peculiarity of the Beacon process is the peculiar mechanical pump used in the exhaustion of the bulbs, by means of which it is alleged that a better vacuum can be obtained in 20 minutes than in two hours by the mercury process employed in the Edison factory. The majority of the employés among the lamp-makers are women, and the average daily output of the factory is 30 lamps per person. The author contends that the silk filament, when properly treated, averages 25 per cent. longer life than the bamboo filament preferred by Edison.

How the Carbon Brush Came Into Use.

A LARGE volume of current when handled at a high potential with direct-current apparatus gives rise to one annoying phenomenon which came near to making a total wreck of the entire electric-railway system, as we now know it. That phenomenon was the intense and destructive spark which appeared at the metallic commutator brushes. In the substitution for metal, of that strange substance, carbon, which has so often come to the rescue of the baffled electrical inventor, an effectual remedy was found. In a note in the *Electrical Engineer* (October 3) Professor Elihu Thomson in his usual graceful manner, gives the credit of this important application to the pioneer electric railway inventor, the late Charles J. Van Depoele, not forgetting however to mention that a similar suggestion had been made by Professor George Forbes in a British patent five

years earlier, which apparently bore no practical fruit.

Illuminating Efficiency of Arc-Light Carbons.

CENTRAL-STATION managers have long suspected that there must be a great difference in the light-giving capacity of different brands of arc-light carbons, but experimental data on the subject have heretofore been almost wholly wanting. In the *Electrical Engineer* (October 3) W. F. Stine reports the result of tests made in the laboratory of Armour Institute, in which several well-known commercial makes of carbons were compared, and a variation found between the average of different brands of from 18 to 36 per cent. Were it not for the fact that the great brilliancy of the arc renders the eye a poor photometer, such a wide variation as 30 per cent. would be commercially ruinous to any company undertaking to furnish lights to the public.

A Small But Profitable Electric Lighting Plant.

IT has long been admitted that one of the most difficult problems in the whole range of the electrical industries is that of getting a dividend from a small electric station. As an interesting contribution to the discussion of this question, the *Electrical Engineer* (September 26) publishes an illustrated description, by Franklin L. Pope, of a small central station operated by water-power which has been running for more than a year past in Peterborough, N. H., a rural manufacturing town of about 2500 inhabitants. The author clearly shows that the unusual success of this particular plant is due wholly to intelligent and skilfull engineering and construction and the careful adaptation of the general plan of the work, as well as the details, to the requirements of the particular situation. Perhaps the most striking fact about the whole affair is, that although the dynamo is situated at a distance of between three and four miles from the district which is lighted by it, the whole business, at both ends, is successfully managed and operated by a single man. There are many places in the New England and Middle states, where the conditions are certainly no less favorable than at Peterborough for the establishment of an electric lighting plant, and it would seem that the example here given might in many cases be followed with profit and advantage. In fact the owners and managers of larger plants might find many points of interest and value in Mr. Pope's graphic and minute description of this little plant. His figures show quite conclusively that it is possible to earn a dividend of some 14 per cent. on an investment estimated at $11,000.

Chips From a Storage Battery Workshop.

THE knowledge we now possess of the laws of life and of health has for the most part been derived from the dispensary, the hospital and the dissecting-room. The storage-battery has been, thus far, but little less of a scientific mystery than the human organization, and it looks as if a knowledge of its idiosyncrasies could only be gained by analogous means. In the *Electrical Engineer* (October 3) Mr. James K. Pumpelly gives a graphic and entertaining résumé of some of his observations and experiences in a hospital devoted to the repair and rehabilitation of diseased and worn-out storage battery plates, in which may be found the clue to more than one of those mysterious and calamitous failures which have so tried the patience and depleted the purse of every one who has ever had anything to do with that "mule of science"—the storage-battery. It is a timely and valuable paper.

Electrical Manufacturing in Canada.

ELECTRICITY is destined to do great things in the future for the Dominion of Canada, especially in the industrial development of its numerous and extensive water-powers. Few people are aware of the extent of the electrical manufacturing interests of Canada, and it is therefore with a feeling of surprise that one reads the interesting and profusely illustrated account of the works of the Canadian

General Electric Company at Peterboro, Ont., by T. C. Martin in the *Electrical Engineer* (September 19). This is one of the most extensive manufacturing concerns in the British colonies, and is by far the largest manufactory of electrical goods; indeed, so far as variety of product is concerned, it probably has but one rival, even in the mother country. Every conceivable article used in electric-lighting and electric-railway service, from dynamos and street-cars down to watch-work meters and incandescent lamps, is turned out in great quantities and of a grade of workmanship comparing favorably with that of any other establishment in the world.

The Power Line From Niagara to Buffalo.

THE route and manner of construction of the power-line which is to transmit a portion of the energy of Niagara to the city of Buffalo has been a matter of much anxious consideration among those interested in this great enterprise. We learn from the *Electrical Engineer* (October 3), that an overhead line is to be constructed in duplicate by two different routes, one of which comes from the plant on the Canadian and the other from the plant on the American side. The route is principally along a special right-of-way 30 feet wide, which has been secured through the farms on Grand Island in the Niagara river. The total distance from the power-house to the Buffalo city limits, as the line is now located is only 13.25 miles. Steel poles and porcelain insulators are to be used.

The 5000 Horse-Power Dynamos for Niagara.

THE secret of the details of the mammoth dynamos now in process of construction for the electrical distribution plant at Niagara has been very closely kept, but by some means not stated, the *Electrical Engineer* appears to have got hold of it, and publishes (September 26) a sectional drawing, with descriptive text and some of the principal dimensions of this electrical monster. It has a fixed armature and horizontally rotating field, which at a speed of 250 revolutions per minute, produces two alternating currents in quadrature, each of 775 amperes and 2250 volts. The alternations are at the rate of 50 per second. It closely resembles in many of its features the design exhibited by Professor George Forbes before the London Institute of Electrical Engineers about a year since, which excited so great an interest and so much adverse criticism in professional circles.

Home-Made Electrical Instruments.

THERE is no possible way in which the student can arrive at so thorough an understanding of any piece of mechanism as to construct, with his own hands, either the machine itself or a working model of it. For this reason, Mr. G. E. Dunton has conferred a real benefit upon the electrical student and amateur, by furnishing minute and explicit directions, with all needful illustrations, for constructing a serviceable form of ammeter and voltmeter for measuring the volume and potential of electric currents. Mr. Dunton's article will be found in the *Electrical World* (September 22 and October 6) and will enable any one having a reasonable amount of skill in that class of handiwork to construct efficient and handsome instruments.

The Toronto Municipal Plant.

REFERENCE was made in this department last month to proposals which had been invited by the city engineer of Toronto for the construction of an arc-lighting plant for that municipality. According to the *Electrical Engineer* (October 10), the lowest bid for a complete city plant was $253,007, on which, allowing interest at 4 per cent. and depreciation at 6 per cent., the annual fixed charges would be $25,300, and the cost of maintenance $75,295. For 1300 street lights, this would involve a cost to the city of $77.37 per light per year. The local electric lighting company determined to hold the business if possible, put in a bid of $72.82½ per light per year. This bid was accepted, and accordingly the local company will, for the

present at least, continue to do the city lighting of Toronto. But contractors who have spent much time and labor in making estimates and preparing bids for the new plant will hardly be particularly gratified to find that the only use made of their elaborate figures is that of a club to knock down the prices of a local electric lighting company.

Lightning Protection for Electric Circuits.

THE Franklin Institute Committee on Science and Arts has awarded the John Scott medal to Alexander J. Wurts, of Pittsburgh, Pa., for his original improvements in apparatus for protecting electric circuits from the destructive effects of lightning discharges. The report of the committee is published in the *Journal of the Franklin Institute* (October). Mr. Wurts' device for the protection of alternating circuits consists of seven cylinders of metal, each one inch in diameter and three inches long, mounted vertically side by side, and separated from each other by spaces of one sixty-fourth of an inch each. The central cylinder is connected to the earth and the two outer ones to the outgoing and return wires of a high-tension alternating circuit. When an electrical discharge to the earth takes place, either from one side or from both sides simultaneously, it is found that the flash is instantaneous, and is not followed, as is ordinarily the case, by an arc, while the change in the strength of working current in the circuit is too small to be appreciable. After-examination of the cylinders shows a slight black pit or burn where the discharge has passed. Mr. Wurts' discovery is that this property of non-arcing is one which is confined to certain particular metals and combinations of metals. The most common of these are zinc and antimony. With these metals it is impossible to start and continue an arc, provided thee are separated by an air-gap of one sixty-fourth of an inch. Mr. Wurts has also devised a complete system for the more effectual protection of long high-potential circuits, which consists in placing at various points, impedance coils of low resistance. These points, according to Mr. Wurts, become points of reflection for the high-frequency surging, which he considers to be the essential characteristic of lightning discharges. Mr. Wurts' devices are cheaply manufactured, and are said to act very effectively in preventing damage by lightning, and this without interrupting the normal course of operations upon the circuits.

Over-Compounded Dynamos in Parallel.

THE cross-sections of the conductors in a multiple-arc system of electrical distribution are determined on the basis of a certain percentage of loss in the conductors at some particular load. The loss in the line increases from zero at no load to the designated percentage at full load. In order to maintain a constant pressure at the initial point of distribution, the dynamo is often over-compounded, so that the pressure at its terminals increases progressively with the increase of current. In a paper in the *Electrical World* (October 13) Professor E. P. Roberts shows that when two or more dynamos are connected in parallel and each compounded in the usual manner for a definite line loss, the automatic regulation of voltage aimed at will only be attained in case all the dynamos are kept in circuit. If one or more be disconnected when the load is light, those remaining will over-compound, not for the current in the line, but for the current in their armatures. In case only one machine is left in circuit, and that heavily loaded, it is possible for a maximum increase in pressure to take place when the load is at its minimum, and in case the load is of incandescent lamps, such a result might be disastrous to them. The remedies suggested are, either a multiplicity of independent circuits, which means the abandonment of parallel working, or else the use of rheostats in the shunt circuit which would seem to entail considerable waste of energy. Editorially, the *World* suggests the employment, in such cases, of plain shunt dynamos. Perhaps there may be still other practical ways out of this difficulty.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated W=Words.

Lighting.

*24952. Domestic Electric Lighting Plants. Nelson W. Perry (E Mag-Nov.) 3000 w.

25079. Electricity at the Wild West Show. Ill. (E W-Sept. 15.) 1200 w.

*25129. The Incandescent Electric Lamp Problem. Sydney F. Walker (C G-Sept. 7.) 1800 w.

25199. The "Feeder and Main" Patent Declared Void.—Judge Acheson's Decision (E R N Y-Sept. 19.) 4500 w.

*25281. Some Points on the Electric Lighting of Interiors (I & I-Sept. 7.) 2000 w.

*25315. The Cost of Glow Lamp Lighting. Extract from Work of J. A. Fleming (El-Sept. 14.) 1600 w.

*25317. The Illuminating Power of Projectors. F. Nerz (El-Sept. 14.) 1800 w.

25333. Internal Wiring. E. J. Erskine (A & B-Sept. 22.) 2800 w.

25334. The Incandescent Electric Lamp. William E. McKay (A G L J-Sept. 24.) 2200 w.

25392. Electric Lighting by Water-Power at Peterborough, N. H. Ill. Franklin Leonard Pope (E E N Y-Sept. 26.) 3200 w.

*25484. The Candle-Power of Glow Lamps. J. A. Fleming (El-Sept. 21.) 900 w.

25576. The Fire Risks of Electricity. S. H. N. (A G L J-Oct. 1.) 2000 w.

25605. How Shall We Meet the Competition of the Welsbach Burner? Ed. M. Highlands (E E-Oct.) 600 w.

25608. Concealed Electric Wiring in Modern Structures. Ill. Charles G. Burton (E E-Oct.) 1600 w.

25615. The Influence of Arc Light Carbons in the Candle-Power. W. M. Stine (E E N Y-Oct. 3.) 450 w.

*25683. Governing Electric Light Engines. Editorial (Eng L-Sept. 28.) 1400 w.

*25741. Photometric Magnitudes and Units. André Blondel, with Editorial (El-Sept. 28.) 7000 w.

*25742. The Electricity Works at Ealing.—Novel Departure in Central Electric Light Station Practice. Ill. (E E L-Sept. 28.) 10000 w.

25756. The Possibility of Securing Better Regulation at Central Light and Power Stations by Means of Fly-Wheel Accumulators of Improved Construction. Ill. John Galt (C E N-Oct.) 6000 w.

Power.

*24970. Storage Batteries. Henry F. Joel (E E L-Aug. 31.) 2500 w.

24982. Driving Mills and Factories by Electricity.—Its Economy Discussed by an English Engineer (B J C-Sept. 8.) 1000 w.

25051. Approaching Trials of Electric Locomotives (R G-Sept. 14.) 1300 w.

25082. How to Make a Dynamo Excite Itself. Ill. George T. Hanchett (E W-Sept. 15.) 2800 w.

25237. Method of Operating Electric Motors. Ill. (Ir Age-Sept. 20) 2200 w.

25302. Electricity on Highways. Possibility of Electrical Traction on Ordinary Railroads Not Likely to Be Fulfilled (B J C-Sept. 22.) 900 w.

25421. The Best Proportions of Armature Diameter and Length in Dynamos and Motors. Ill. M. H. Johnson (E W-Sept. 22.) 600 w.

†25498. Motor Repairs. James F. Hobart (S R J-Oct.) 1500 w.

25619. On Multiple Series Control of Motors on Small Electric Railways (E N Y-Oct. 3.) 1100 w.

25657. Power Transmission at Niagara Falls. Ill. (W E-Oct. 6.) 5400 w.

25658. Alternating Current Motors. L. M. Pinolet (W E-Oct. 6.) 3500 w.

Telephony and Telegraphy.

24995. The Commercial "All-Submarine" Cable from New York City to Europe. Ill. (E E N Y-Sept. 12.) 1400 w.

25035.—$1.50. The Load Line in Telephone Exchanges. Ill. A. V. Abbott (T C E-July.) 3300 w.

*25103. Determining the Position of a Fault in a Submarine Cable Between the Repairing Ship and Shore Station, when the Conductor Is Not Broken, by the "Fall of Potential Test." Ill. J. Rymer Jones (E R L-Sept. 7.) 2300 w.

*25254. Telegraphy Up to Date. George J. Varney (L Mag-Oct.) 3200 w.

*25267. Submarine Telegraph Property (E-Sept. 14.) 1100 w.

*25354. On the Minimum Current Audible in the Telephone (E R L-Sept. 14.) 2500 w.

*25355. An Attempt at a Quantitative Theory of the Telephone. Lord Rayleigh (E R L-Sept. 14.) 1500 w.

25377. Telegraphic Reminiscences. Charles Selden (E R N Y-Sept. 26.) 1300 w.

25419. The First Direct New York Cable. Ill. (E W-Sept. 22.) 2800 w.

25426. Duplex Telephony. Ill. T. R. Rosebrugh. (E W-Sept. 29.) 1600 w.

25752. President Plum's Address to the Military Telegraphers (E R N Y-Oct. 10.) 3000 w.

25755. Cable Construction and Cable Faults. Ill. F. J. F. Schwartz (C E N-Oct.) 2000 w.

Miscellany.

24991. Duncan Meter for Alternating Currents. Ill. W. S. Resor (E R N Y-Sept. 12.) 900 w.

24993. Schroon Lake: The Summer Diversions of an Electrical Amateur. Ill. (E E N Y-Sept. 12.) 2400 w.

We supply copies of these articles. See introductory.

25011. The Recent Accidents Occasioned by High-Tension Currents. M. G. Claude (E N Y-Sept. 12.) 3000 w.

†25058. Alternating Currents and Fuses. Dugald C. Jackson and R. J. Ochsner, with Discussion (T A I E E-Aug. and Sept.) 3000 w.

†25059. A Study of the Residual Charges of Condensers and Their Dependence upon Temperature. Frederick Bedell and Carl Kinsley. (T A I E E-Aug. and Sept.) 3000 w.

25080. The Discharge of Magnetism. Ill. M. A. Agelasto (E W-Sept. 15.) 1800 w.

*25104. The Capacity and Constitution of Dielectrics. Rollo Appleyard (E R L-Sept. 7.) 1000 w.

*25110. Integrators, Harmonic Analyzers, and Integraphs. Ill. O. Henrici (El-Sept. 7.) 4000 w.

25192. A Phonographic Method for Recording the Alternate Current Curve. Ill. C. J. Rollefson (E N Y-Sept. 19.) 600 w.

25195. The Development of Electric Manufacturing in Canada. Ill. T. C. Martin (E E N Y-Sept. 19.) 4800 w.

*25316. The Rise of Current in Inductive Circuits. Ill. Alexander Russell (El-Sept. 14.) 1500 w.

25376. The Testing of Insulated Wires. Ill. R. Varley, Jr. (E R N Y-Sept. 26.) 800 w.

25425. Engineering Education and the State University. (Abstract) William S. Aldrich (E W-Sept. 22.) 1900 w.

*25459. The Velvo Carbon Battery (E R L-Sept. 21.) 1100 w.

*25481. Alternating Currents in a Divided Circuit. Ill. Alexander Russell (El-Sept. 21.) 1100 w.

†25554. Change of Period of Electrical Waves on Iron Wires. John Trowbridge (A J S-Oct.) 1500 w.

†25555. Wave Lengths of Electricity on Iron Wires. Charles E. St. John (A J S-Oct.) 4200 w.

25602. The Electric Canal-Tugboat. Ill. F. M. F. Cazin (E W-Oct. 6.) 3000 w.

25606. The Life of the Lead Storage Battery. J. K. Pumpelly (E E-Oct.) 900 w.

25607. Commutators. Charles Lake (E E-Oct.) 800 w.

25612. How the Carbon Brush Came Into Use. Elihu Thomson (E E N Y-Oct. 3.) 1100 w.

25616. Chips from a Storage Battery Workshop. James K. Pumpelly (E E N Y-Oct. 3.) 2200 w.

†25650. The Chloride Electrical Storage Battery. Ill. (Report of Committee) (J F I-Oct.) 1400 w.

†25651. Wurt's Lightning Arresters for the Protection of Electric Lighting and Power Circuits. (Report of Committee) (J F I-Oct.) 1000 w.

*25734. Notes on the Design of Large Alternators. Rankin Kennedy (E R L-Sept. 28.) 1600 w.

Serials.

6709. Electric Light and Power. Arthur F. Guy (E E L-Began Sept. 9, 1892—Ended Sept. 7, 1894—40 parts—30 cts. each).

23866. Dynamo-Electric Machinery. Ill. Edwin J. Houston and A. E. Kennelly (E W-Began July 21—10 parts to date—15 cts. each).

24437. Elementary Theory of the Induction Alternating Motor. Rankin Kennedy (E R L-Began Aug. 10—2 parts to date—30 cts. each).

24508. Magnetic Leakage in Dynamo Electric Machinery. Ill. Alfred E. Wiener (E E N Y-Began Aug. 22—6 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Ill. Newton Harrison (E A-Began Aug. 25—6 parts to date—15 cts. each).

24826. The Rise of Electricity. J. Mount Bleyer (E R N Y-Began Sept. 5—Ended Sept. 12—2 parts—15 cts. each).

24884. Electricity in the Modern City. Thomas Commerford Martin (J F I-Began Sept.—Ended Oct —2 parts—45 cts. each).

24942. The Potential and Current Curves of Different Types of Alternators, and Their Influence on the Candle-Power of Alternate-Current Arcs. Ill. G. Rössler and W. Wedding (El-Began Aug. 31—Ended Sept. 7—2 parts—30 cts. each).

24969. The Use of Accumulators with Motors. Ill. M. G. Darriens (E E L-Began Aug. 31—Ended Sept. 7—2 parts—30 cts. each).

25095. Postal Telegraphs. Ill. James Bell (E L-Began Sept. 7—4 parts to date—15 cts. each).

25105. Standard Units for Electrical Measurement (E R L-Began Sept. 7—1 part to date—30 cts).

25420. How to Make a Voltmeter and an Ammeter.—For Amateurs. G. E. Dunton (E W-Began Sept. 22—2 parts to date—15 cts. each).

25424. The Earth as an Electrical Conductor. John Henry Hoit (E W-Began Sept. 22—2 parts to date—15 cts. each).

25461. A General Theory of the Glow Lamp. H. S. Weber (E E L-Began Sept. 21—1 part to date—30 cts).

25482. The Chemical Theory of Accumulators. E. J. Wade (El-Began Sept. 21—2 parts to date—30 cts. each).

25483. The Construction of Resistances. D. K. Morris (El-Began Sept. 21—2 parts to date—30 cts. each).

25743. The Board of Trade Standards and Standardizing Laboratory (E E L-Began Sept. 28—1 part to date—30 cts).

INDUSTRIAL CHEMISTRY

How Shall Young Men be Educated in Applied Chemistry?

THIS very timely question has recently been discussed at some length by Dr. Peter T. Austen in the *Pharmaceutical Era*, and his remarks are reprinted in the *Scientific American* supplement. Dr. Austen emphasizes the growing importance of the chemist in manufactures, engineering, metallurgy, agriculture and indeed in all branches of modern industry, his intimate relationship with all these arts, and the need of a broad and liberal education to give him the proper grounding for any one of the multifarious specialties and functions he may select for his life work or may be called upon to assume. Since the future of a chemical student is often so uncertain the author recognizes the impossibility, in a strict sense, of laying out a course of study that would perfectly fit a man for each and all of the wide range of specialties; and holds that the training is not intended to do more than to ground a student thoroughly in the principles and practice of the science in such a way and to such an extent that he may be able to take up any application he may choose and follow it up by independent study and experimentation. The author's experience is drawn upon to point out the nature of a course of study, as followed in our best technical schools, and improved to accomplish the desired end; and he remarks that in some respects somewhat different courses are called for in the United States than in Germany, one cause among others being the wide difference which exists between the preparatory school education of the two countries. He insists upon a thorough drill in English branches as a preliminary, and considers the ability to read German a great advantage to the chemist who would keep pace with the times, inasmuch as most of the chemical literature is in that language, while indeed most of the chemical progress is now in Germany. Dr. Austen's ideal of a general education including history, the elements of law, political economy, mathematics, metaphysics, logic, ethics and literature is probably unattainable by the average chemical student in these busy days. It might be summed up in a requirement that the student should have taken a full course in a first-class college before entering upon his technical training; but the time and expense required preclude this for the majority of young chemists.

Coming to the direct training, Dr. Austen thinks that in many institutions the instruction in chemistry is too much confined to analysis, and that the graduates, although good analysts, are handicapped when entering a manufacturing works, where the difficulties and the methods are altogether new. The course should begin in the laboratory, and with a thorough and elaborate drill in experimental chemistry. Personally conducted experiments in chemistry and physics alone can induce originality of thought and give a comprehensive grasp of these subjects. Simultaneously a lecture course, well illustrated by experiments and accompanied with continued quizzing on the lectures, should go on. After experimental chemistry is completed, the author recommends a course in blowpipe analysis, followed by qualitative and then by quantitative analysis; and that, toward the end of the instruction in the latter, instruction in the preparation of pure substances should be given. During the course a carefully considered set of lectures should be delivered on technical chemistry, and special attention should be devoted to the relationship between manufactures. The technical collection should be well stocked, and visits should be made to representative manufactories.

It is gratifying to note that Dr. Austen gives prominence to a course of instruction in what is now termed "chemical engineering." While admitting that this is a difficult subject to teach, he believes that there are great possibilities in it, and inci-

dentally suggests that there is here an excellent opportunity for a good text book. In study the various operations of precipitation, solution, evaporation, stirring, heating and filtration and the various mechanical devices should be grouped, independently of particular substances treated, and rather by substances of allied properties to be considered and manipulated in comprehensive groups. This line of study embraces the steam plant, pumps, vacuum and pressure apparatus, etc.

After outlining the usual curriculum, with many suggested additions and some innovations in details, the author lays stress upon the desirability of a year's post-graduate course devoted to higher chemical study undisturbed by other work. It is needless to say that a student who has conscientiously gone through the elaborate course delineated by Dr. Austen (and of which it is impossible to give here an adequate summary), would be very thoroughly equipped for beginning general practice or, with some experience and specialization, for almost any one of the numerous branches into which the rapidly developing science and art of industrial chemistry have been subdivided. It is to be regretted that comparatively few can avail themselves of so complete a training; but the number is growing, and consequently also the number of competent practitioners, while the tendency is constantly toward better work.

Yorkshire College Industrial Classes.

THE *Chemical Trade Journal* contains an abstract of a recent report on the industrial department of the Yorkshire College, England, giving special attention to the work done by the classes studying the dyeing and the leather industries. Interesting researches have been made in both branches. Reports have been made on the composition and coloring principle of various dye stuffs and the action of light on colors.

Experiments made upon the chrome tanning processes have pointed to the best methods of manufacture and proportions of materials, while good samples of various leathers thus tanned have been turned out. The chrome method has been found applicable to the manufacture of glazed kid, and especially suitable for glove leathers because of softness, toughness and resistance to damp; also for imitation chamois, which has the advantage over the genuine of being easily and permanently dyed in almost any shade, with other good qualities and cheapness; for laces, belts, etc.; and as a substitute for calf-kid, having great durability, though somewhat lacking in fineness of grain; for "patent" and enameled leathers, etc. The analysis of leathers, it is believed, is of much importance to manufacturers, who have scarcely realized how much information may be gained in this way as to the methods of producing a given leather. Other researches have been made on oils and stuffing greases, presenting difficulties in really scientific analyses. The trade is recognizing the value of reliable methods and is showing interest in the analysis of tanning materials. The report indicates that the industrial department of the college is being conducted on thoroughly practical lines, and is suggestive to similar institutions.

Electrolysis of Alkaline Chlorides.

AN illustrated paper on the electrolysis of alkaline chlorides for the preparation of caustic and chlorine is communicated by Mr. H. Y. Castner to the *Engineering and Mining Journal*, the cuts showing the new plant of the Aluminum Company, Limited, at Oldbury, England. The difficulty with all processes for electrolyzing alkaline chlorides has been to prevent the recombination of the products dissociated; to which end either special porous diaphragms or impervious substances have been used to keep apart the resulting products, or a fused electrolyte has been used, or mercury has been employed as a cathode only, with water treatment to remove the sodium in the amalgam. The Castner process is designed (1) to prevent recombination and the formation of hypochlorites, which destroy the electrodes, render the solution unfit for continuous use and decrease electrical efficiency; (2) to effect a large de-

composition per watt per cell; and (3) to obtain strong and pure solutions. The new process employs mercury (which is an old idea), but radically differs from former methods. Its essential features are continuity, the use of a moving body of mercury which completely separates the products of electrolysis, the sodium amalgam being decomposed electrically as rapidly as formed. The cells are in three compartments (the center for mercury, the outer trio for chloride solution), and are made to rock from side to side. An arrangement of pipes and vats allows continuous circulation of the chloride solution, which is regenerated by passing through "saturators," and the drawing off of the caustic and chlorine in a pure state. The details of the plant are quite ingenious, and great c aims are made for the efficiency and economy of the process.

Industrial Uses of Cellulose Thio-carbonates.

THESE interesting substances and their recently discovered derivatives have found numerous practical applications which have been worked out by Mr. A. Little, who lately communicated his results to the chemical section of the Franklin institute, and the *Chemical Trade Journal* now publishes a résumé showing the stage thus far reached. While at first many difficulties were encountered, development is now going forward very rapidly; and at present the most promising applications are as a substitute for glue and ebonite and as thin films for artificial leather, floor tiles, etc. There are now six commercial forms available: the crude solution, dense cellulose in the mass, separate films and sheets, films and sheets on cloth backing, porous cellulose, and various admixtures of cellulose and foreign substances such as untreated fiber or mineral matter. The raw material of almost all products yet made is in the form known to paper makers as soda fiber made from poplar; but it has been pointed out that any other cheap or convenient form might be used.

A 1 per cent. solution serves for billposting, bookbinding and the manufacture of straw boards, and has been extensively used, while experiments in the use of a stronger solution as a substitute for glue in carpentry indicate success, with a large balance as to cost in favor of cellulose. A 10 per cent. solution is as heavy as can be worked to advantage, while a 5 per cent. solution is as viscous as a 50 per cent. hot solution of glue. For the permanent stiffening and sizing of cloth there appears to be a large field for the decolorized weak solution, as also for collars, cuffs and shirt fronts. It may also be used as a vehicle in pigment printing on cloth, the solution being previously mixed with the pigment. A very dilute solution of thio-carbonate with alum finds application in paper sizing. The dense cellulose, formed by allowing the solution to revert or decompose, separating as a jelly, may be hardened and worked in any direction, resembles ebonite in appearance, takes a high polish, and can be used as an insulating material, or for buttons, tool handles and other small articles. The films may be made as clear as glass, or may be readily colored. Very many applications for them have already been found, as for photographic films, glazing of binders' board, facing blotters, imitation vellum, etc. Films on cloth may be used for curtains, bookbinding, upholstery, interior decorations and floor covering. The porous cellulose is adapted for fancy printing, embossed hangings, boxes, signs, etc., and it is claimed that the structure of the sponge can be reproduced. The list of applications of the solution in admixture with various foreign ingredients, as wood pulp and other fibers, clays, etc., is a long one and is partially suggested in the foregoing enumeration of some tried or prospective uses. Mr. Little's account opens out a very inviting field for the new compounds.

Adulteration of Essential Oils.

FROM the United States consular reports the *American Analyst* derives some remarkable statements as to the extent to which adulteration of the essences of lemon, orange, etc., is practiced in Sicily, and especially with regard to the essential

oils prepared for export. French turpentine is the chief adulterant, and attempts have been made in the Italian chamber of deputies to places an almost prohibitory duty upon this substance, in behalf of the fruit producers, who are interested quite as much as the foreign consumers of the sophisticated products. The consul at Messina, who has been investigating the matter closely believes that adulteration can be stopped by several methods, the best one of which appears to be a refusal to buy except upon chemical analysis, with certified copies of the report. This course is not much favored by importers, however, although it is a safe one and comparatively inexpensive, analyses of large invoices of the same quality costing no more than on small lots. The polarimeter, now the principal reliance, is declared to be useless for tests, since the manufacturer can produce adulterated essences, having the same optical rotation as pure goods, by judiciously proportioning his ingredients. The instrument may be of great value to the honest manufacturer in ascertaining the optical rotation of his own product; but there its usefulness ceases. To test the accuracy of chemical analysis, many series of prepared samples were submitted to local chemists, whose reports agreed with practical precision with the known composition of the samples. The consul is confident that importers can secure pure essences if they are willing to pay for them.

A COMPOUND largely sold and used for preserving fruits and other perishable food, has been analyzed by Mr. H. A. Huston, who in the *American Analyst*, says it consists of sulphur (57.63 per cent.), cane sugar 14.20 per cent.) a little common salt as an accidental impurity, some nitrate of soda (1.36 per cent.), and 25.64 per cent. of charcoal, moisture and insoluble matter. The compound is burned in a closed space and the fumes absorbed by water; and the fruit, etc., should be exposed to the fumes and finally placed in the sulphurous water. The process is not approved.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

24955. Chemistry in the Foundry (E M J-Sept. 8.) 500 w.

24958. Recovery of Ammonia from Blast Furnace Gases (E M J-Sept. 8.) 1000 w.

24980. Peat Fuel in Germany (A M & I W-Sept. 7.) 1000 w.

25041. Tie and Timber Preserving Works at Las Vegas, N. M.; A. T. and S. F. Ry. Ill. F. Meredith Jones (E N-Sept. 13.) 1200 w.

*25092. Oxygen as a Cure for "Gassing." Editorial (C T J-Sept. 8.) 1200 w.

*25093. Industrial Classes at the Yorkshire College (C T J-Sept. 8.) 800 w.

25197. Adulteration of Essential Oils (A An-Sept. 15.) 2300 w.

25198. An Objectionable Food Preservative. H. A. Huston (A An-Sept. 15.) 500 w.

25224. Chemistry at the British Association (Sc A S-Sept. 22.) 1800 w.

*25310. Blast and Counter-Blast (C T J-Sept. 15.) 1600 w.

*25312. Industrial Uses of Cellulose Thiocarbonates (C T J-Sept. 15.) 1500 w.

*25320. Canaigre as a Substitute for Bark in Tanning (B T J-Sept.) 500 w.

25338. Electrolysis of Alkaline Chlorides for the Preparation of Caustic and Chlorine. Ill. H. Y. Castner (E M J-Sept. 22.) 2000 w.

25390. How Shall Young Men Be Educated in Applied Chemistry? Peter T. Austen (Sc A S-Sept. 29.) 6200 w.

†25522. Method for the Determination of the Freezing Point of Fatty Acids. F. Wolfbauer. Translated by S. S. Emery (J A C S-Oct.) 1500 w.

†25523. The Determination of Volatile and Insoluble Fatty Acids in Butter Fat. W. H. Beal (J A C S-Oct.) 900 w.

†25525. An Apparatus ("Lysimeter") for Determining Solubilities. Charles Rice (J A C S-Oct.) 700 w.

†25550. The Standardization of Potassium Permanganate in Iron Analysis. Charlotte F. Roberts (A J S-Oct.) 600 w.

†25656. Some Recent Contributions to Our Knowledge of Metallic Reducing Agents. H. F. Keller (J F I-Oct.) 3800 w.

*25705. The Chemical Pulp Process in the States (C T J-Sept. 29.) 1000 w.

*25706. Chemical Trade with Japan (C T J-Sept. 29.) 700 w.

Serials.

25094. Distillation. R. Tervet, Jr. (C T J-Began Sept. 8—2 parts to date—30 cts. each).

*We supply copies of these articles. See introductory.

INDUSTRIAL SOCIOLOGY

A Trilogy.

THE *Forum* may be regarded as one of the best vehicles of thought published in America, particularly of that kind of thought which is fecundated and incubated in the libraries of professors in institutions of learning, and the study rooms of clergymen. In classing this as a kind of thought by itself no disparagement is intended. The thought of men devoted to study and learning has great value in dealing with fundamental principles of ethics, science and philosophy. In grappling with practical problems, it lacks something. A man may be perfectly competent to work out mathematically and in accordance with the laws of physics and mechanics all the principles involved in the construction of a proposed machine, and yet may be utterly incompetent to draw such practical plans and specifications for its construction as would enable skilled constructors to build even a working model, not to say one that would be satisfactory in its operation. Considering social organization, somewhat as we would a machine, that is to say, as something involving both theory and practice, knowledge of principles and skill in construction, it is not surprising that writers who possess singly the one or the other should, in dealing with professed social reforms, fail to work out practicable schemes. The magazine named has of late dealt with social questions very largely, and in its October number has printed three papers, the perusal of which has suggested what is here written. These articles, two of which are so interesting as to hardly admit of choice between them, are respectively entitled "Fundamental Beliefs in My Social Philosophy," by Prof. R. T. Ely; "Ely's Socialism and Socialistic Reform," by Prof. A. T. Hadley, and the "Contented Masses," by Octave Thanet, which is of a wholly different style. The two articles first named are, as literary productions, singularly felicitous in style, and embody much profound thought of the kind already alluded to. The title of Mr. Thanet's paper will be misleading to most readers, who will expect from it a much broader discussion than they will find in the paper itself.

The "Contented Masses" of whom Mr. Thanet writes with a glowing pen, constitute the population of Scott county, Iowa, comprising 43,164 souls, all told (the average real estate mortgage debt is $72 per head), and containing within its happy borders the city of Davenport, a town of 30,000 inhabitants, and several villages. Estimating the population of the villages as 3000, there remain 10,164 people who presumably are the farmers of Scott county. Mr. Thanet's paper deals principally with the farmers, so that the masses whose content he calls to public attention narrow down to rather a small percentage of the entire population of the United States. These people are exceptionally favored if we are to accept all that Mr. Thanet has to say about them. He tells us "there is no question that it (Scott Co.) is one of the wealthiest and most thriving of the counties" in Iowa. "It believes in honest money, in the moderate use of the good things of life (including wine, spirits and malt liquors), in the full payment of debts, and in the protection of individual rights and property." Each citizen has on the average three times as much property as he has debt. The county poor house is not crowded, and the recent hard times have not materially increased the number of its tenants. The people are more charitable than in most places. There are several homes for old women where snuff and patent medicines are supplied to inmates who desire them; and one old woman is permitted to enjoy her stump of a pipe in the seclusion of the cellar. All of which goes to show that content of the masses promotes kindness of heart. The onions raised in Scott county are noted far and wide for size and quality, and the

strawberries would also be as widely known could they bear shipment as well as onions. Altogether, the snuff and the short pipe, the onions and the strawberries, including wine, spirits and malt liquors, impart a mild and genial fragrance to the air of Scott county which presumably helps toward the almost blissful content of its population. However, its roads are confessedly bad, and this renders farm life lonely and isolated in the season when the roads are at their worst; and Mr. Thanet admits that the farmer's compulsory "dependence upon the Lord in the matter of sun and rain mysteriously inclines a man to gloom." Yet in spite of forced dependence upon the Lord, and the bad roads, the Scott county farmer lives in great comfort; "his daughter has a piano, and his wife a silk gown."

A similar charming picture is painted of the provincial workman of Scott county, as he is found in the city of Davenport, and in the several villages mentioned. The walking delegate is at a discount in Davenport, and the villages manage to exist without him. Davenport we are told "is known in labor circles as 'the scab town.'" Mr. Thanet says "Mr. Howells' traveler from Altruria, before he shakes the dust of our country from his feet, and goes away to weep over us, should go for a brief space to a western town. There he might find manufacturers who voluntarily advance wages, and workingmen who voluntarily work overtime." The traveler from Altruria, not up in his geography, is minded to ask whether or no Pullman and Chicago, in which it has been currently reported there were slight labor disturbances recently, are western towns?—and why does not everybody follow Horace Greeley's advice, and go west?

Of Prof. Ely's social philosophy no fairer summary can be presented than is given by Prof. Hadley in the same number of *The Forum*.

1. Political economy makes the individual an end, in and for himself; in other words it is a gospel of Mammon and glorification of selfishness.

2. Socialism substitutes collective aims for individual ones. It is the result of a moral reaction against the traditional political economy,—a reaction which is taking hold of the masses, and which they are inclined to carry to an extreme.

3. The only way to prevent matters from being carried to such an extreme is for the wealthy and intelligent classes to adopt a great many socialistic measures on their own account, before the control of our social machinery is taken out of their hands.

This gives in condensed form the substance of Prof. Ely's contentions; the arguments by which he seeks to support them must be read as a whole to appreciate them; limited quotation would only misrepresent them.

Prof. Hadley regards the first of the above propositions as a mistake. He asserts that "political economy does not regard the individual as an end in himself"; and that "it does not glorify the pursuit of wealth except so far as this pursuit serves the interests of society as a whole." He deprecates "the so-called moral reaction against the teachings of economics" and charges that it is "in fact not so much a moral as an emotional one." Yet he claims not "to undervalue the emotional element in dealing with economic matters as men of purely intellectual type are prone to do."

Reasoning about human conduct is full of chances of error; and if the outcome of such reasoning is to leave a considerable number of human beings in hopeless misery, society is justified in demanding that every promise and every inference in the chain of reasoning be tested, and every rational experiment be made to see whether such a consequence is really inevitable. Instances have not been wanting when the conclusions of the economists have proved wrong, and the emotions of the critics have been warranted by the event. The factory legislation of England furnishes an historical example. The economists, as a rule, condemned this legislation as wrong in principle and likely to do harm; but the results showed that these economists had overlooked certain factors of importance with regard to public health and public morals which vitiated their conclusions and justified public opinion in disregarding them.

He thinks it "safe to say that the harm done by laws based on unemotional reasoning is but as a drop in the bucket compared with that which has been done by

laws based on unreasoning emotion." This mistake of allowing emotion to influence thought and action unduly, Prof. Hadley criticises in Prof. Ely's philosophy; and his paper is chiefly directed to the refutation of the first of the three propositions which are thought to fairly represent this phase of economic discussion.

Railway Companies and Their Employes.

In this the third of a series of papers written by Mr. Ossian D. Ashley, President of the Wabash railroad, for the *Railway Age*, he comes out flat-footed in the advocacy of profit-sharing, after an interesting review of the present industrial situation. In this paper, as giving a fair example of Mr. Ashley's views, the following paragraphs are conspicuous:

In Europe adjustment of relations between labor and capital is a more threatening factor of disturbance than in this country (United States), and in that part of the continent where monarchical governments are the most absolute, the struggle is likely to be attended by tumult and bloodshed, which, under popular government, can be avoided. This conclusion is based upon the idea that underlying this question between labor and capital in Europe and adding to its strength and virulence, runs the current of protest against the political as well as social inequality of the people. And thus, that portion of Europe which adheres to even a qualified absolutism in its form of government is the hotbed and nursery of the extremists who lead most offensively in the ranks of socialism under the names of anarchists, nihilists and communists. The solution of this great problem in Europe it is needless to discuss here; the end is not within sight of the present generation, and even if we conclude that governments by the people will eventually prevail, human foresight cannot fix the period of its accomplishment. This view of the status of socialism in Europe, as compared with its growth and existence in the United States, will not, perhaps, be shared by Europeans who look upon the surface of popular movements in this country and think they detect in them a condition of society dangerous to the stability of republican government; but this conclusion is not accepted by those who have carefully studied the subject on the spot, for reasons given in my last paper.

The true solution of the social problem presented in the extract at least in the United States Mr. Ashley thinks will be found in the system of profit-sharing, for the trial of which he strenuously argues. In order to afford "a practical illustration of the idea," he supposes an employer and employé to reason each with himself. The manufacturer says:

"If I can secure greater intelligence, greater industry and greater skill, I can utilize these valuable services so as to add to the superiority of my fabrics and economize in their cost, and thus add to my profits, I can well afford to distribute annually a fair proportion of these profits to the working men who have enabled me to obtain this success. It is for my interest to encourage these people who are trying to make our enterprise a success, and I will do it with great pleasure. We have but one object in view, and that is to succeed, and in that success to which they contribute so much, they should participate."

On the other hand the employé says: "My employer is willing to give me some share of his profit beyond my wages, if he is successful; he believes that I have aided to the best of my ability to secure that success, and I propose to give him the benefit of my best exertions, hoping to aid in making his enterprise prosperous. We are all engaged in a work in the success of which we are all interested."

The author then asks: "If such relations can be established between employers and employed, and the conditions fairly carried out, would it not go far toward solving the social problem satisfactorily?" From which it will be seen that Mr. Ashley regards profit-sharing as a panacea, whose trial will demonstrate its value as a remedy for social ills. Under the assumption that "it would be fairly carried out," doubtless it would relieve many of the strains in the relations between employers and workmen; but the writer does not fortify this assumption by anything which to the reviewer seems to carry the weight of assurance. However, he proceeds very ably to deal with "the ways leading to a practical accomplishment of the plan," and not only this, but other parts of the discussion will command earnest attention, on the part of those who either advocate or oppose as impracticable the proposed system of

profit-sharing. It is evident that Mr. Ashley has much broader and more practical views on this subject than many contemporaneous writers. He admits, that in the nature of the case, "movements directed toward the establishment of a system of profit-sharing must be for a time experimental, and he sees that to be successful, "the hope of something higher and better in life" as a "constant incentive to exertion," and some system of promotion must go hand in hand with profit-sharing which will render it acceptable to the employed. Among other important innovations, he advocates pensioning off disabled and superannuated employés, who have been faithful in their service, holding that employers as well as employed should contribute to a fund for this purpose.

This able series of papers emphasizes two facts which are becoming very conspicuous in the current literature of industrial sociology; namely, that some of the ablest thinkers on this class of subjects are not occupying professorial chairs in universities and colleges, and that some of the best contributions to the discussion are now appropriately appearing in the technical journals, rather than in the reviews and literary magazines, or in the daily newspapers.

The Conundrum of "Labor Day."

"WHAT is the meaning of Labor Day?" Thus asks Mr. E. C. Gardner in the *Springfield Republican*, and adds remarks that fully justify the pertinence of his query. Another writer signing himself (or herself) "A Pleased Reader" having replied to the question in rhyme, the first-named writer replies to "Pleased Reader" also in rhyme, which brings out a counter-reply from the latter once more couched in rhyme. The *American Architect* prints the whole together under the title above given. In opening the subject Mr. Gardner asks:

> Can you tell me what in heaven's name is the meaning of our new national holiday and why should it be called "Labor" day? What is it intended to commemorate or celebrate, and how should it be observed? If I should advertise to-morrow for 50 "laborers" I should probably have the next morning from 50 to 500 applicants bringing their strong arms and possibly a shovel or a hod by way of tools. There would not be one among them who could shoe a horse, weld a piece of steel, hang a roll of paper, solder a joint, make a chair, a box, or window-frame, plane a board, lay a brick, act as a motorman or conductor on an electric car, and still less handle a locomotive. They would be "laborers" pure and simple, and the advertisement would be properly answered. If I wanted anything else I should have to advertise for something else, for farmers, mechanics, clerks, teachers, or whatever it might happen to be. Now, there is nothing in common, unskilled labor that we need to exalt and glorify, to celebrate with the timbrel and the harp, the fire-cracker and the lunch-basket. It is indispensable and honorable, of course, if well done, but its spirit and achievement are not a sufficient cause for a national thanksgiving.
>
> If "labor" is not thus restricted, then every man, woman and child who works either from necessity, choice, sense of duty or greed of gain, is a laborer. Whether the work is done with the hands, or the head, the feet or the mouth, it is work, and whoever does it is a laborer. He or she may be a clerk, a hod-carrier, a teacher, mechanic, farmer, engineer, commercial traveler, banker, lawyer, or journalist, manufacturer, milliner, typewriter, philanthropist, explorer or inventor: each and all belong to the world's great army of "laborers," and while there may be intrinsic, as there certainly are many factitious reasons given for esteeming one kind of labor as more desirable and worthy of respect than another, there can be no difference in the degree of honor that is due to those who are willing to do their part in the world's work according to their opportunity and ability; and no degrees in the dishonor that rests upon those who are willing to shirk it. Any other ground than this is absolutely undemocratic, un-American and un-Christian. The situation is too simple to admit of argument.

The rhyming answer to this refers Mr. Gardner to the politicians for a reply.

> "Who with a little shuffling and evasion
> Will show the need of labor recognition."

In the replication, Mr. Gardner winds up a humorous poem of three stanzas with the following problem:

> Please tell me in these active days of "pull" and
> "hustle,"

And tell me just as plain and clearly as you can,
In what proportions of clear brain and healthy muscle,
You would compound a genuine laboring man?
Inform me, and with me the many million masses
Just where the line 'twixt "laborers" and "non-laborers" passes.

ENVOY.

If all of us are "laborers" since creation was begun,
Then in the words of Tiny Tim--God bless us, every one.

To which in a poem of eight stanzas "Pleased Reader" makes a rejoinder, struggling in the fourth stanza rather desperately to solve the conundrum propounded by Mr. Gardner.

The laborer—in the popular dictionary—
Is one, it seems to me—hum—one who labors—
Hum—labors for another, something chary
Of paying larger wages than his neighbors;
Not, on the whole, a pampered proletary,
Who thinks he merits timbrellings and tabors
(I need that word in abors) and is wary
Of us who, being buoyed in the swim,
Seem to his ear, to condescend to him.

There is reason as well as rhyme in this playful debate, which may set some people thinking, who do not as a rule do as much thinking as is profitable in these perplexing times.

A Lesson in Industrial Economy.

PEOPLE of fair education, says the *Journal of Gas Lighting* (London) editorially, are in the habit of thinking that the foundations of the science of political economy "were laid by Adam Smith, and that the structure has been solidly built, in a plain but useful style of architecture by Ricardo, Bentham, Mill, and a host of other thinkers down to Prof. Marshall." Yet the writer of the article quoted finds, nevertheless, that public men at the present time are wont "to say and do things calculated to raise doubts as to the truth and utility of what have been taught as the fundamental data of this particular science."

In other words, instances daily occur in which, and a personage to whom prominent politicians to quote the immortal Captain Cuttle, the bearings of the observations of the political economists should lie in the applications thereof—and these applications are never made. Indeed, most of what is interesting and living in the industrial developments of the times, appears to spring up and struggle on without the slightest reference to the precepts of the science which is supposed to treat of the springs of action of mankind, as traders and producers. We see this illustrated by our Trade Union Congresses, Independent Labor parties and other manifestations of the working of the Time Spirit among the poorer classes in the community. If there is a science of political economy, there ought not to be a John Burns, or a Tom Mann, or a Keir Hardie. Yet these representatives of revolt against the established system of industrial society are in high feather, and take delight and find profit in saying things in the ears of the people of a nature to drive an orthodox political economist "howling to his gods."

The writer while deprecating the effect of attempts of "blind men to lead the blind through the mazes of the densest problems ever presented to painfully striving humanity," argues that all efforts to educate men of the agitator class spoken of as "Tom Mann," etc., are vain.

The mischief is that common workmen will not join classes for the study of political economy, even if the cultured professors of this science of the study and the arm-chair would care to have them for pupils. They will not of deliberate intent study anything, or read anything but newspaper reports of murders, bigamies, and sporting events. There are moments, however, when these men have nothing to do, nothing to think about, and nothing to say: and these idle times are the agitator's opportunity, of which he is not usually slow to avail himself. Not many years ago, the peripatetic socialists who went in for this class of business used to hold forth wherever they found a handful of loafers, and send round the hat when they had done speaking. This crude proceeding had the invariable effect of dispersing the assembly; and the poor orator was left comfortless. At last, a happy idea occurred to some of the astutest of the talking fraternity—they called themselves Trade Union leaders, and sold cards of membership instead of begging for coppers. The plan worked like a charm; and the out-at-elbow socialist of the last decade is now, if he knows how to keep decently straight, a member of parliament, an alderman,

usually deem it advisable to be civil—but he has learned no political economy the while.

The specimen passages quoted would seem to indicate the article to be a virulent attack specially directed toward labor leaders as ignoramusus in all that pertains to economics and as agitators for mere mercenary ends, rather than for the advancement of the crafts they represent. But this would be to misconceive the motive of the writer, who holds that "the employer is often just as bad—worse, indeed, inasmuch as he ought to know better. Ask him how it is that trade is bad, or how it is that his particular trade is getting away from him and into other hands, and the chances are greatly in favor of his uttering in reply as many and as grievous economic fallacies as can be found in an average socialistic oration."

The article is really (though at first it might appear differently) an able argument against the position assumed by members of the Iron and Steel Institute, after having visited Belgium (the Belgian competition in the steel and iron trades being generally "a very sore point with English traders"), that the Belgians are beating them because the latter work long hours for little pay. Against this fallacy the writer of the editorial under review sets the full force of a weighty pen,—mighty because he who uses it to express his thoughts has real thoughts to express. He sees that "behind the question of wages rates lies, for the employer, that of the cost of labor; and for the workman, that of the commodities he can obtain for his week's pay." He holds that "both employers and employed are apt to look too exclusively at the mere wages rate, which is against all economic teaching, and is distinctly reactionary." He regards the movement in the direction of profit sharing as by no means a panacea, "but rather as a concession to the humane sentiment which seeks in the modern industrial world some such interest in his employment as the journeyman of old possessed in the hope of becoming a master in his turn.'

We are told that in Belgium all employés are given an interest, not in the profits, but in their position, "They get more than money." When one proceeds to inquire what this additional something is, it is found to consist of cheap lodging—provided by the employer; free schools—also provided by the employer; and cheap flour and other necessaries, supplied at about cost price from the employer's stores. These advantages are supposed to satisfy "Les braves Belges," and keep them from striking like their English fellows. If this is so, the Belgian workman must be a very easily satisfied man; for part payment by "truck," whether to the employer's profit or not, never yet made an English or an American workman contented.

The situation is viewed hopefully, however. The lesson which a workman needs to learn is how to save for himself, instead of, as in profit sharing, "trusting to his employer to save for him. As the day of the small master is passing away," the author hopes that "the day of the small investor is dawning."

Stokers and Pokers.

Two kinds of labor the details of which are not very familiar to the public, yet which are generally believed to be extremely exacting and exhausting, are what are known in the gas industry as "poking" (a new term defined below) and stoking. Those who are in search of material relating to the labor employed in various occupations will do well to read what is said upon this subject in the *Journal of Gas Lighting* under the above title, in an article of more than ordinary interest contributed by Mr. Thomas Newbigging. He divides the employés of gas works into four classes, viz.: (1) skilled workmen, (2) stokers, (3) laborers, (4) the official class, such as engineers and managers, secretaries, chemists, clerks, foremen, storekeepers, meter inspectors, and collectors. Stokers are considered as laborers, and there is still another class which he styles "pokers"—"philanthropical and emotional pokers" of their noses into other people's business. It is presumably these pokers who are considered by Mr. Newbigging as creating a good deal of misplaced sympathy for the stokers, whose work as described in the article appears not to be more severe than most laborers' work. The interest of the article is well sustained from beginning to end.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

24971. The Planters' Meeting at the Hotel Royal (L P-Sept. 8.) 7500 w.

24972. The Donaldsonville Meeting of Sugar Planters (L P-Sept. 8.) 4200 w.

24979. Workmen's Houses Tenure (R R-Sept. 8.) 800 w.

*25008. Stokers and Pokers. Thomas Newbigging (J G L-Sept. 4.) 2500 w.

25064.—$1. The Ultimate Standard of Value. E. von Böhm-Bowerk (An A A-Sept.) 21500 w.

25065.—$1. Relation of Labor Organizations to the American Boy and to Trade Instruction. E. W. Bemis (An A A-Sept.) 10800 w.

25066.—$1. The Beginning of Utility. Simon N. Patten (An A A-Sept.) 1800 w.

25067.—$1. Present Condition of Sociology in the United States. Ira W. Howerth (An A A-Sept.) 4000 w.

25068.—75 cts. Are We Awakened? H. von Holst (J P E-Sept.) 13300 w.

25069.—75 cts. Gold and Silver in Santo Domingo. J. Lawrence Laughlin (J P E-Sept.) 9800 w.

25070.—75 cts. The Formula of Sacrifice. H. J. Davenport (J P E-Sept.) 5200 w.

†25087. The Gold Question. An Appeal to Monometallists (N C-Sept.) 6000 w.

†25089. Britain and the United States.—Cost of Living Compared. Andrew Carnegie (C R-Sept.) 4000 w.

†25091. "If Christ Came to Chicago." Goldwin Smith (C R-Sept.) 4600 w.

*25125. The Industrial Competition of Nations. Editorial (E-Sept. 7.) 2800 w.

*25133. Labor and Wages in Belgium. Editorial (Eng L-Sept. 7.) 2500 w.

†25142. Philosophy and Industrial Life. J. Clark Murray (Mo-July.) 5600 w.

†25143. Co-operation and the Agricultural Depression. Edmund Mitchell (W R-Sept.) 3000 w.

25172. The Tennessee State Convict Mine. L. E. Bryant (E M J-Sept. 15.) 1000 w.

25216. State Ownership and Protection of Forests (E N-Sept. 20.) 3500 w.

25236. The Tariff and Our Coal Trade (S V-Sept. 15.) 2000 w.

25248. A Labor Day Talk.—Address of Joseph R. Buchanan (J M W A-Sept. 22.) 3800 w.

†25256. Some Anarchist Portraits. Charles Malato (F R-Sept.) 9000 w.

†25258. Imaginative Currency Statistics. J. Barr Robertson (F R-Sept.) 6300 w.

*25265. The Trades Union Congress, 1894. Editorial (E-Sept. 14.) 2200 w.

*25276. Profit-Sharing in the Coal and Iron Trades. D. F. Schloss (C G-Sept. 14.) 6300 w.

25287. The Conundrum of Labor Day. E. C. Gardner (A A-Sept. 22.) 1000 w.

*25314. The Miners Strike in Scotland and Sliding Scales (I C T-Sept. 14.) 2200 w.

*25321. German Commercial Unions (B T J-Sept.) 1800 w.

*25322. Establishment of an Official Department of Labor in Spain (B T J-Sept.) 650 w.

*25328. The Economic Condition of Japan (J S A-Sept. 14.) 1700 w.

25331. Rights of Land Owners. Editorial. (A & B-Sept. 22.) 1200 w.

25335. Bimetallism vs. Silver Monometallism. R. P. Rothwell (E M J-Sept. 22.) 3000 w.

25370. Harmony vs. Monopoly (B D-Sept. 22.) 700 w.

*25396. Fundamental Beliefs in My Social Philosophy. R. T. Ely (F-Oct.) 5000 w.

*25397. Ely's "Socialism and Social Reform." A. T. Hadley (F-Oct.) 3000 w.

*25398. The Contented Masses. Octave Thanet (F-Oct.) 6000 w.

†25402. The Municipal Problems of London. George Robert Tyler (N A R-Oct.) 3500 w.

*25429. A Lesson in Industrial Economy (J G L-Sept. 18.) 2000 w.

*25447. British Railway Traffic and Strikes. Editorial (E-Sept. 21.) 2500 w.

*25450. The Scotch Coal Strike. Editorial (Eng L-Sept. 21.) 1500 w.

25465. Labor in Non-Union Mills. Editorial (A M & I W-Sept. 28.) 700 w.

*25491. Declaration of the Bimetallist Members of the German Silver Commission. Translated by E. Benjamin Andrews (R of R-Sept.) 4500 w.

†25495. The Youngstown Street Railway Strike (S R J-Oct.) 1600 w.

†25496. Taxation. Allen Ripley Foote (S R J-Oct.) 4400 w.

25507. The Depression and the Employment of Labor. George M. Steele (B C-Sept. 29.) 700 w.

25511. Lessons of the Strike. G. W. Rhodes (R R-Sept. 29.) 2000 w.

*25520. Scientific Money. T. W. Graham (Mill-Sept.) 1700 w.

†25533. Is the Friction Between Employed and Employer Diminishing? Albert S. Bolles (C M-Oct.) 2800 w.

*25570. Profit Sharing in the Coal and Iron Industries. Editorial (I C T-Sept. 21.) 1600 w.

Serials.

24586. Railway Companies and Their Employés. Ossian D. Ashley (R A-Began Aug. 24—4 parts to date—15 cts. each).

We supply copies of these articles. See introductory.

MARINE ENGINEERING

Marine Mechanical Stoking.

MECHANICAL stoking has made considerable progress on land in stationary engine practice; but for locomotives and marine engines very little has been accomplished in this direction up to the present time. There are difficulties to be met in machine stoking for these classes of engines as contrasted with stationary which very much enhance the intricacy of the problem. Those who wish to gain some knowledge of these special difficulties, in so far as relates to marine boilers, will do well to read a series of articles entitled: "Is a Marine Mechanical Stoker Impracticable?" written by Mr. Sidney H. Holland, and commenced in the *Mechanical World* (London and Manchester), Sept. 7.

The writer starts out with the declaration that "the very greatest desideratum of the age, is, in all probability, a practicable mechanical stoker, or other firing apparatus adapted for marine purposes"; and any one familiar with the way coal is now passed from the coal bunkers and fed to the boiler furnaces on large steamships, will not be disposed to dispute either the declaration, or the pertinence of the query which this writer makes the title of his article.

Every large steamer carries quite a small army of skilled laborers, to be provided for in stores, accommodation, and pay, forming at least four-fifths of the entire steam staff, whose duty involves the most arduous toil imaginable, and whose working lives, are as a rule, thereby prematurely worn out and shortened. From a humanitarian point of view, the obviation of this present necessity would be an incalculable boon; and on commercial and financial grounds, an efficient automatic substitute for all this manual labor would seemingly be the greatest acquisition that the steamship owner and the marine engineer have yet known. It seems somewhat of an anomaly that having now developed all other accessories of the marine engine and boiler to such admirable comparative perfection, we should still be laboriously trudging along with hand-stoking. It is remarkable that nothing has yet been achieved in this direction, considering the great desirability of, and equally great demand for, such a machine when once produced in a practical and efficient form. Are there insuperable difficulties in the way of changing all this?

Pursuing the subject further the fact is noted that for stationary boilers, "several fairly good mechanical stokers, and at least two excellent ones have been produced," and these are meeting with merited approval and extending use. A gas stoker (West's) is also mentioned as being a fairly efficient machine, though the difficulties met with in the invention and construction of such a machine appear to Mr. Holland as at least equal to those attending the construction of a marine stoker.

In reporting the results of a competitive trial of machine stokers last year, Mr. E. Ingham, consulting engineer, of Oldham, said: "There is no question whatever in my mind that hand-firing is doomed to give place to some form of automatic machine-firing in the immediate future." There really seems but little doubt that we must eventually come to mechanical marine stoking, or automatic firing in another form.

The author then proceeds to discuss three possible lines in which mechanical stoking for marine purposes may be developed; to wit, "a development of the best existing forms of land machine stokers using coal, the use of hydrocarbon liquid fuel, and the use of gas fuel." He then passes in review the various forms of land machine stokers, and competitive trials of these machines, concluding this first number of the series with an enumeration of the advantages of machine stoking in general, as compared with hand labor stoking.

With no desire to undervalue the importance of the subject of which the first paper of this series gives good promise that it will be ably treated, it seems to the

reviewer that the revolution now in progress with marine boilers is likely to replace boilers hitherto used by water-tube boilers, and this may so change the conditions of the problem in a few years that premature effort directed towards the evolution of marine mechanical stokers is likely to be wasted. However, this remark may, perhaps, anticipate what the author of the series intends to say in future numbers of the series.

Trials of Dynamite.

THE first attempts to throw shells charged with high explosives from guns, through the agency of air compressed to from 800 to 1000 pounds to the square inch, and upward, were made in 1886 under the auspices of the U. S. Navy Department. The first pneumatic gun made for the purpose was built at the Delamater Iron Works in New York city. The measure of success attending experiments with the first gun made, indicated possibilities which encouraged further experiment, and efforts toward improvement have been constantly put forth since the time mentioned, and with gratifying results. *The Iron Age* has printed a résumé of the progress made thus far, beginning with the first government trial of the pneumatic system in 1889, and extending down to the recent trials with 8-inch and 15-inch pneumatic guns at Sandy Hook. The reports of the chief of ordnance have always been favorable to continued experiment with the system. The following paragraph quoted from one of the latest of these reports shows how the subject is regarded in the U. S. War Department.

Each time the conclusion has been more or less favorable. Each report, however, has stated that the accuracy of the guns leaves much to be desired. It is manifest that the accuracy of a gun is its most important quality, and without a satisfactory degree of accuracy all other advantages are of minor importance. The difficulty in the pneumatic guns appears to center in the main valve which admits the air to the gun. At all ranges except the maximum the successful working of the gun demands that this valve should open and close in an exceedingly short time, probably a small fraction of a second. The difficulties encountered in accomplishing this have not been overcome. The department has already expended $30,000 upon experiments with these guns without any decided improvement. Without entering further, at this time, into the merits of the system, the bureau recommends that further experiments be deferred until after the installation at Sandy Hook of the 15-inch guns now in course of construction for the War Department. In these guns the company promise to overcome the difficulties which exist in those of the *Vesuvius*.

The article reviewed states that the recent trials have proved that the defects in the valve alluded to have been remedied. It adds that "the tests also proved that the guns could be rapidly handled and that the shot could be delivered with certainty at any point within range of the gun." These results show that an important addition has been made to the destructive appliances of modern warfare.

The terms of the contract made by the government with the Pneumatic Dynamite Gun Company demanded that the 8-inch gun must be able to cover all ranges from 100 to 2600 yards with a shell containing 100 pounds of explosive gelatine, and from 100 to 3200 yards with shells containing 50 pounds. The 15-inch gun, with 50 pounds, must range from 100 to 5500 yards; with 100 pounds, to 4500 yards; with 250 pounds to 3550 yards; with 500 pounds, to 3000 yards.

The rapidity of loading and firing varies with the amount of the explosive in the shell, but the time must not exceed three minutes for one shell of 500 pounds, or forty minutes for ten consecutive rounds. For a shell charged with 200 pounds, two minutes are allowed, or 27 minutes for ten consecutive rounds. The rate of rapidity continues to increase with smaller charges, ten rounds in 20 minutes being reached. The 8-inch gun will be fired five rounds with 50 and five with 100 pounds in the shell, while the 15-inch will be fired three rounds with 50, eight with 100, ten with 200, and five with 500. The remaining gun of this caliber, if those tests are successful, will require only half a dozen proof rounds for testing its general working ability.

These tests for rapidity are said to have exceeded the requirements. The range can be changed without change of eleva-

tion in the gun, by "controlling the amount of compressed air that escapes at each discharge." The mechanism by which this is effected, the system whereby the reservoir is always kept stocked with compressed air, and the system of loading the gun, are all described in this very interesting article.

Past and Present Steamship Records.

IN these days of record breaking both on the part of our great Atlantic liners and with our new cruisers, nearly everybody could find pleasant reading in an editorial résumé under the above title which is printed in the *American Shipbuilder* in its issue of September 13th. This is a running statement,—substantially chronological—of the records made from and including the first voyage of the *Britannia*, the first ship of the famous Cunard line, up to date. Interesting particulars of dimensions, kind of propelling wheel (paddle or screw), dates of first voyages of once famous ships, whose glory has since been eclipsed, etc., accompany the records of their speed. The following is abstracted from the article named.

The first Cunard steamer, the *Britannia*, achieved a speed, from 8¼ to 8½ knots an hour. The average duration of the Cunard voyages in the year 1856 was 12.67 days from Liverpool to New York, and 11.03 days from New York to Liverpool. The *Bothnia*, in 1874, reduced the passage to about 9 days. The White Star *Britannic*, in 1876, averaged 7 days, 18 hours, 26 minutes, outward from Queenstown to New York, and 9 days, 6 hours, 44 minutes on the return. The *City of Berlin*, of the Inman line, also built in 1874, made the westward voyage in 8 days, 10 hours, 56 minutes, and eastward in 8 days, 2 hours, 37 minutes. From the year 1874 to 1879 no further advance was made in Atlantic steaming, but in the latter year the *Arizona* was added to the Guion line, and it soon became evident that another important stride had been made in the Atlantic passenger trade which would lead to most important results. The Guion line, which had started in 1866 with the *Manhattan*, had now the fastest passenger steamer on the Atlantic. In spite of burning some 50 per cent. more coal than the *Britannic*, she was an obvious commercial success. The spirited policy which brought her into existence was appreciated by the public, and the other lines had to move forward. Then followed a period of rivalry, the Cunard Co. building the *Gallia* and *Servia*, the Inman line the *City of Rome*, and the Guion line the *Alaska*, all of which were completed in 1881, and afterward the *Oregon*, in 1883; the *Aurania* the same year, and later still the *America* for the National line, and the *Umbria* and *Etruria* for the Cunard Co. in 1885. From the 15 days' passage or thereabouts of the earliest Atlantic steamers we have got down to 5 days, 9 hours, 27 minutes.

A Serious State of Affairs.

THE fact that there is not a single dry-dock in the United States large enough to dock the new battleships of which the nation (barring the doubts that have recently been cast upon the integrity of their armor plates) feels justly proud, is the theme of a good editorial in the *American Shipbuilder*. The sea is a treacherous element, and any of these ships might meet with accident in encountering its perils at any time. This would imperatively demand immediate repairs. That we do not possess facilities for making such repairs, and would have to seek foreign dry-dock accommodation in such an event is justly regarded by the paper quoted, as "a humiliating position for a great nation to be in."

The question arises why is it that there is so much delay in completing the Brooklyn Navy Yard Dry Dock, which is to be the largest in the world, and is the only one in this country, except those now under construction at Port Royal and Puget Sound, in which the new battleships can be cleaned? The Brooklyn dock was originally to be 600 feet long and to cost $412,000. Its length has lately been increased to 670 feet and price to $462,619.18.

It appears from this article that the contractor to whom the contract for constructiug this dry-dock was awarded, has been so dilatory in executing the work as to have been "repeatedly warned that the progress he was making was not satisfactory to the Government," and that he has been "permitted to continue the work under certain assurances which, it is said, have not been fulfilled." The article also states that the contractor has now been "notified to show cause why his contract

for constructing the New York Navy Yard dock should not be cancelled."

The Navy Department is censured for preferring the bid of a contractor inexperienced in this kind of construction to that of an experienced company that makes a specialty of such work; the only apparent reason for such action being that the former offered to do the work for $125,000 less than the latter. The *American Shipbuilder* now insists that this was false economy, and asserts that the Government would have saved both time and money by giving out the contract to the company that made the higher bid, rather than to a contractor who had "never built a structure of that kind.

"Is the Government obliged to accept the bid of such a person in lieu of men of long experience in dock constructing, and who have made it a life study, simply on account of a difference of a few thousand dollars? If so it is time there was a change in the statutes."

This is followed by a history of the advertising for bids for the construction of timber dry docks at Brooklyn and Norfolk navy yards, and for dry docks at other points, the names of those who bid for the contracts, and the opening of the bids and awards, with facts relating to Government dry-docks now built and in operation, compiled from the Washington correspondence of the *Brooklyn Eagle*, all of which points clearly to the fact that previous awards of contracts of this kind to contractors inexperienced in such work have almost uniformly resulted in imperfect construction and loss to the Government.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*25003. On a Rapid Method of Calculating Wetted Surfaces. Archibald Denny (M E-Sept.) 700 w.

*25004. Messrs. Blackwood and Gordon's Shipbuilding Yard, Port Glasgow. Ill. (M E-Sept.) 500 w.

25017. Trials of Dynamite (Ir Age-Sept. 13.) 1300 w.

25037. Past and Present Steamship Records (Am S-Sept. 13.) 700 w.

25043. The Design of Ferry Steamers. Ill. Abstracts of papers by Edwin A. Stevens, Andrew Brown and Charles Jones (E N-Sept. 13.) 6500 w.

*25101. The Progress of Steam Navigation (P Eng-Sept. 7.) 4400 w.

25211. The Elevator Barge Company.—System of Coaling Steam Craft by Patent Steam Power Elevators. Ill. (Am S-Sept. 20.) 250 w.

25231. The New American Liners (Sea-Sept. 20.) 2200 w.

25242. The Cramp Ship-Yard. Ill. Fred H. Colvin (M A-Sept.) 2000 w.

†25257. The Naval Manœuvres. Nauticus (F R-Sept.) 4600 w.

*25266. The Work and Cost of the Navy. Editorial (E-Sept. 14.) 2500 w.

*25269. The Decennial Programme for Naval Construction in France (Eng L-Sept. 14.) 4000 w.

*25270. The Decadence of Shipbuilding on the Mersey (Eng L-Sept. 14.) 2000 w.

*25309. British Mercantile Marine and Its Protection (Tr-Sept. 14.) 500 w.

*25451. The Vibration of Steamships. Editorial (Eng L-Sept. 21.) 2000 w.

*25458. The Decay and Failure of Tail Shafts in Steamers. Ill. (I & I-Sept. 21.) 1400 w.

25561. The United States Armored Cruiser "Maine." Ill. (Eng-Sept. 29.) 3600 w.

*25575. Quadruple-Expansion Engine for Third Class Torpedo-Boat. Ill. (A E R J-Oct.) 2000 w.

†25652. The Centrifugal Pumping Plant at Mare Island Navy Yard, California. Ill. John H. Cooper (J F I-Oct.) 2500 w.

25665. A Long Island Sound Palace—The City of Lowell. Ill. (Sea-Oct. 4.) 3000 w.

*25679. The Harbors and Ferry System of Denmark. Ill. A. E. Carey (E. Sept. 28.) 2500 w.

Serials.

16636. Marine Engine Design (M W-Began Oct. 6, 1893—14 parts to date—30 cts. each).

21969. The Shark and the Sailor. A. Ewbank (I E-Began April 14—18 parts to date—45 cts. each).

24695. The Guns and their Mountings of Spanish Belted Cruisers. Ill. (E-Began Aug. 24—Ended Sept. 7—2 parts—30 cts. each).

24868. American Ships for American Commerce (Sea-Began Sept. 6—Ended Sept. 13—2 parts—15 cts. each).

25010. Is a Marine Mechanical Stoker Impracticable? Sidney H. Holland (M W-Began Sept. 7—Ended Sept. 14—2 parts—30 cts. each).

We supply copies of these articles. See introductory

MECHANICAL ENGINEERING

Hardened Rollers as Pressure Bearings.

THE extended use of roller and ball bearings is one of the features of current mechanical progress. It is, however, entirely safe to say that many data yet remain to be added before our knowledge of this class of bearings will be complete. A contribution to further knowledge of the subject has been contributed to *American Machinist* (Sept. 27) by Mr. Oberlin Smith. In this article he explains that he was led to a closer study of roller bearings, by the contemplation of the construction of "a press for coining purposes with rolling toggles," for the designing of which he prepared himself "by investigating to some extent the available pressures attainable upon convex cylindrical surfaces of hardened steel, when rolling upon a plane, or upon other convex surfaces of the same material." As this excellent article contains many diagrams and tables, all that will be undertaken in reviewing it will be to impart an idea of the method pursued in the investigation, and this can best be done by quoting the author's description of it which follows. For the data of the respective experiments and tests the reader must consult the article itself, which occupies about four columns of the paper in which it appeared.

I prepared several blocks of an ordinary quality of tool steel, hardened in water and tempered to a straw color, which I afterward had submitted to compression tests in the large United States testing machine at Watertown, made by Mr. Emery. The respective radii of these blocks were 1 inch (marked 1 A); 2 inches (marked 2 A); 3 inches (marked 3 A); 4 inches (marked 4 A) and 5 inches (marked 5 A). Their length, parallel to their axes, was approximately 1 inch; their width, at right angles to the same, 2 inches, and their height, in a radial direction, about 1 inch. There was another block (marked 4 B) whose length was a little over 2 inches. The length of the working face of these blocks which formed the line of contact upon the lower or anvil block was about ½ inch less than the figures above given, as the lower corners were beveled off at an angle of 45 degrees, the cross section of metal removed being, therefore, a right angled triangle with a base of about ½ inch.

The anvil block upon which these were tested was of the same material and measured about 4 inches square by 1 inch thick.

The results of these tests as reported by Captain Varney, commandant of the Watertown Arsenal, are then given in tabulated form with diagrams, and may prove a valuable addition to previously obtained data; yet before accepting them they ought to be confirmed by further tests. Mr. Smith calls attention to the remarkably heavy pressure which the specimen pieces sustained, considering that this pressure was borne theoretically by a line of contact only.

Just how wide this contact surface was, we unfortunately do not know, as no means were at hand to measure it. Furthermore, I do not know of any definite method for doing this having been devised, there being nothing of the kind at the arsenal in question. I have in contemplation, however, some future tests where this important point will be taken account of, and wherein some possible methods of measuring these indented contact surfaces, which I have in view, will be tested. Of course, the maximum pressure lies along the central element of the indentation, disappearing gradually towards the edges, where it is *nil*. We therefore should naturally expect a considerably less compressive strength per square inch upon the surface in question than upon flat and parallel surfaces, as in ordinary testing. It will be seen by the report, however, that contact surfaces ¾ inch long, and of some unknown width which probably did not average 1/8 inch, stood ultimate pressures varying from about 128,000 to 184,000 pounds. Now, if these surfaces had been of the same width and both flat, they would doubtless, as above intimated, have stood still greater pressures upon this area which probably amounted to less than one-tenth of one square inch. If we assume this area, and that if flat it would have stood 200,000 pounds only, and if, furthermore, we assume that one square inch of metal would bear a pressure in proportion, we should have some remarkable figures, amounting to 2,000,000 pounds for the said square inch. This

strength at first sight seems, of course, entirely incredible, and yet, there it was.

Was there possible error in these tests that made them give the enormous result computed by Mr. Smith? Is his assumption that no more than one-tenth of a square inch was the area subjected to extreme pressure too small? Is there some property of the cylindrical form that enables it to resist pressure on the surface of contact more than the prismatic form? These are questions that will arise in the minds of mechanical engineers, and the answers to which need the further experiment which Mr. Smith says he contemplates.

Friction Rollers.

ALMOST exactly in line with the experiments at Watertown Arsenal, described by Mr. Smith, is an account of other interesting experiments given in a paper presented at the convention of the Am. Soc. C. E., held in June, 1894, the first part of which was prepared by C. L. Crandall, M. Am. Soc. C. E., the second part being by Prof. A. Marston, Assoc. M. Soc. C. E. The paper is published in the Transactions of the Society (August number) together with the discussion elicited.

The paper treats first of a series of experiments upon rolling friction performed at the college of civil engineering, Cornell University, in 1886, by Mr. C. B. Wing, now professor of structural engineering, at Leland Stanford University. The account of the methods employed, and the tabulated results given, though of interest and value, are not, however, what is above spoken of as in line with Mr. Smith's investigations. The experiments performed in 1887, by Prof. Wing, as fellow in the college, and Mr. Crandall, the author of the first part of the paper under review, were made to determine the life of rollers for different loads and material. Mr. Crandall states that these tests were performed in the following manner.

> They (the rollers) were placed between upper and middle plates and two between the middle and lower plates with their axes all parallel. The full load on the upper plate was thus divided between the two lower ones. The center plate was driven back and forth about ¾ inch, for rotating the rollers by means of a small water wheel acting through a connecting rod upon a rod working in guides and attached to the plate by a flexible joint. The number of turns of the crank was registered by an attached odometer. The scale beam was kept balanced at a constant load during the experiment. Motion was continued until the surfaces were injured by wear; but it was found impossible to reach the same degree of wear with all, first on account of the difficulty of examining the surface until the experiment was stopped and the rollers removed, and second, on account of the long time required to produce wear with the lighter loads.
>
> The wearing effect was toward a gradual rusting of the surface, which changed to a blackening, accompanied with black dust of worn-out material as the wear increased; finally pitting of the surface took place, with a flow of metal at the ends of the rollers and around the edge of the contact portion of the plate.
>
> The elastic limit in compression of a short steel rod about 1 inch in area, cut from the rod which furnished the smaller rollers, was found to be 46,000 pounds, and the modulus of elasticity 31,500,000 pounds. The cast iron gave an elastic limit in a short length of 41,000 pounds, an ultimate of 100,000, and a modulus of elasticity of 14,400,000 pounds, all in compression.

A table of results is given which includes the date of each experiment, number of odometer revolutions, load per lineal inch of roller, different materials of which rollers were made, the materials of which the plates were made, and the condition of both plates and rollers at the end of the tests. Investigations extended to bridge rollers are also noted.

The second part of the paper contributed by Prof. Marston, is, however, in line with Mr. Smith's investigations, and it is one of the most scientific studies of the distribution of stress in rollers subjected to pressure that has appeared in print. The text occupies 22 pages of the Transactions and there are 5 pages of plates. Only the careful perusal of the paper can give any adequate appreciation of the refined scientific methods employed in the investigation, which is based upon "the fact that stressed glass bodies exhibit striking optical effects when viewed by polarized light." This familiar class-room experiment has

been applied by Prof. Marston to the investigation of bridge roller stresses, and the diagrams illustrating optical effects as indicating lines of stress are of very great interest. In a number of cases these effects are illustrated by well executed, tinted engravings, which very much enhance the interest of the paper. A full description of the apparatus employed is given and is illustrated by an engraving. The conclusion is reached that lines of stress in bridge rollers (and inferentially in all rollers of similar materials and analogous use) are what they appear to be in the optical tests, at least approximately—lines of circles. This conclusion is derived mathematically from subjecting the middle lines of the dark bands obtained in the optical experiments to a comparison with lines platted from the equation of the band, under the supposition that the lines of stress are circles; the coincidence was sufficiently marked to justify the conclusion. Several tables are presented, and table No. 4. gives areas of contact obtained by three independent methods, which will be of service in future investigations upon this subject. The paper is in every way a most admirable contribution to current engineering literature, and exhibits a striking example of the refined methods of modern physical research as applied to engineering problems.

Centrifugal Whirling of Shafts.

MR. GEO. R. BALE, Assoc. M. Inst. C. E., has written an article on the above subject for the *Practical Engineer* (London) which is printed in its issue for Sept. 28. The treatment of the subject is both diagrammatic and mathematical, and it places in a clear light the importance of considering the subject in the determination of the positions for shaft bearings, in order to prevent the continued revolution of shafts supported by the bearings) in a bent form, when any small deflection is imparted to them. The line of demonstration pursued by the writer is as follows:

From the reasoning given by Prof. Rankine ("Millwork," p. 549) we may deduce the following formula, giving the limit of length between bearings, which should not be exceeded, for a solid wrought iron or steel shaft—

$$L = 175 \sqrt{\frac{D}{N}}$$

D, being the diameter of shaft in inches,

N, its speed in revolutions per minute, and

L, the greatest admissible length between bearings in feet at which distance the centrifugal force of a slightly bent shaft and the elastic stress tending to straighten it become equal at the given speed. With a less distance between the bearings, centrifugal whirling of the shaft will not take place, as it restores itself to straightness.

By the aid of the above formula the diagram herewith has been plotted, giving the value of L for shafts up to 12 inches in diameter, and for speeds running up to 800 revolutions per minute, by means of which this limiting distance may be readily determined, thus: Suppose we have as our conditions a shaft of 3 inches diameter, running at a speed of 600 revolutions per minute, and it is required to know the maximum distance that may be allowed between the bearings.

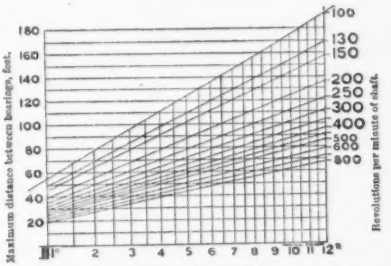


Diagram giving maximum distance between bearings for rotating shafts at which centrifugal whirling does not occur.

At the point marked 3 inches on the scale of diameters of shaft at the base of the diagram, note the intersection of the ordinate with the line marked 600 on the scale of the speed of shaft to the right of the diagram, and read off the corresponding value for L—*i. e.*, 39 feet. Or, again, let us take the case where the position of the bearings and speed of running are fixed by circumstances; then to determine the diameter of the shaft such that centrifugal whirling shall not occur. If L=45 feet, and the shaft is to make 600 revolutions per minute, then D, irrespective of its size necessary for transmitting the power required, should not be less than obtained from the diagram thus: Follow the line marked 600 on the speed scale to the right of the diagram,

until the distance between it and the base corresponds to 45 feet by the scale given for L on the diagram, at which point read off the diameter required—*i. e.*, 4 inches—on the diameter scale at the base of the diagram.

For a hollow shaft the formula given above becomes

$$L = 175 \sqrt[4]{\frac{D^2 + d^2}{N^2}} \text{ feet.}$$

D being the outside diameter of the shaft in inches;

d, the diameter of the hole through the shaft in inches;

N, the speed in revolutions per minute, as before, and

L, the maximum distance between bearings, as before, in feet.

Draughting Room Practice.

THE relation which the draughting room ought to bear to other departments of a manufacturing establishment; the method which will render this department most valuable in its effects upon other departments; the function of drawings as expressing ideas of mechanical objects to be constructed; the importance of careful arrangement, classification, and indexing of drawings, so that each may be readily referred to as needed; the sizes most convenient for use (all things being considered), with examples of indexing by the card catalogue system, together with other matters of interest pertaining to the management of draughting rooms, are treated in a good practical article written by Mr. Walter B. Snow, and printed in *Machinery*. This paper, by the way, is a new venture in the field of American technical literature, and should not be confounded with the paper of the same name published in London. The practical side of machinery construction appears to be the tendency of most of the articles which have appeared in the first two numbers. Mr. Snow's article is directed to greater refinement of practice, and more exact and uniform systems with reference to drawings than is usual in many shops.

An Electro-Magnetic Clutch.

AN interesting mechanical device depending for its action upon the attraction existing between an electro-magnet and its armature has been invented by M. B. Bovet of Paris, and is described in *The Safety Valve* (September 15). As this clutch is a decided innovation in mechanical engineering, illustrations of it are given herewith, the cuts having been kindly loaned us by the publishers of the journal quoted.

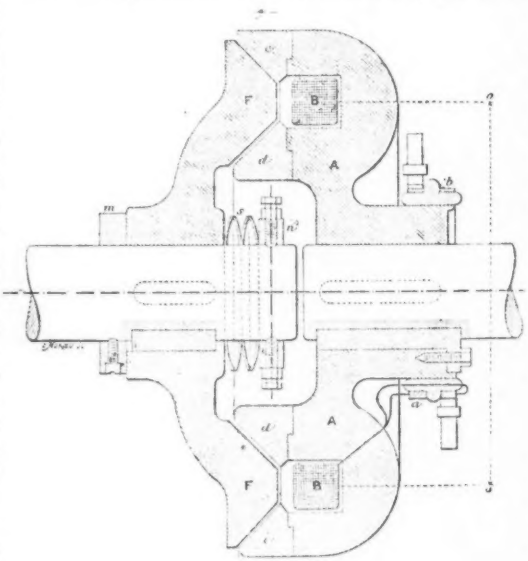


FIG. 1.

In Figure 1, A is an electro-magnet keyed on the end of a shaft. The current is brought in coil B by means of brushes acting on taking up current rings *a* and *b*. The jaws *c* and *d*, being liable to wear by slipping friction, are set in so as to be easily replaced. Rim F, acting as an armature to the electro-magnet, forms the rim of a wheel keyed on the end of another shaft in such a manner that it cannot turn upon it, but liable

to move according to the axis. The displacement is limited by two fixed rings *m* and *n*, the motion being produced in one direction by magnetic attraction, and in the other, when magnetic attraction becomes insufficient or is suppressed, by the action of spring S. The jaws *c* and *d* are fitted in, in order that they may not only be replaced when worn out, but also to enable them to accentuate the action by giving relatively less thickness to piece F, and, consequently, less resistance. It is believed that if it was built with a more permeable metal than the one with which the electro-magnet is made of, it would be better still, and that in a general way, whether one acts on the nature of the metal, or on the sections of

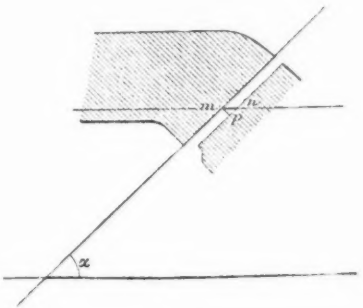


FIG. 2.

thickness, or on both together, it will always be advantageous to close the magnetic circuit in as short a circuit as possible by a piece, which, by provoking magnetism near the contact surfaces, magnetism will cause a decrease of resistance which will in turn cause an influx of force.

The Safety Valve points out that "the wedge shape of the jaws gives a noticeable play to the movable part, while always keeping the active faces near enough together so that the attraction up to contact may be caused by a magnetic field of small intensity and too weak to cause driving." Referring to Figure 2, M. de Bovet says:

"We consider it especially necessary to preserve the wedge shape of the jaws, because with such a shape, to a given displacement *m n* of the armature according to the axis there corresponds a much less distance *m p* = sin *a* of the acting surfaces."

Combined Section Liner and Triangle.

MR. F. R. HONEY, whose name will be familiar to a great many American readers, as a contributor to technical journals, has communicated to the *American Machinist* an account of a new drawing instrument which can be used for all the purposes of a triangle, while it also may be used as a section liner, when the flat shading of a cross section is required. Now there have been various attachments to triangles invented before, and the handy device under consideration would not therefore attract much attention except for certain features of its construction that appear to be new, and also appear to largely increase the range and usefulness of this labor-saving

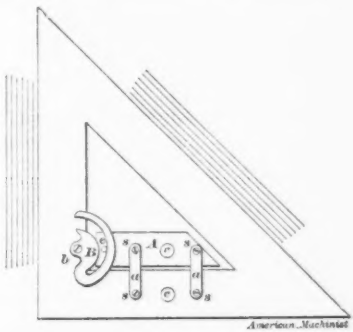


Fig. 1

device over others that have preceded it. The monotonous and tedious labor of cross hatching by the old method is one that all draughtsmen would be glad to have lightened and facilitated; and by the use of this new attachment, which can easily be fitted to any triangle, it would seem that a material saving in time, strain of vision, and back-ache, can be accomplished. Mr. Honey has previously described in the same paper a section liner devised by himself. This one, however, has been contrived by Mr. O. F. Hill, of Lowell, Mass. The *American Machinist* has obliged us with a loan of the cuts illustrating the device, which are here reproduced. Referring to these, the following is Mr. Honey's description of the device and the manner of using it:

"Figure 1 is an ordinary 45 degree triangle. Within the opening space is a piece *A* of the same thickness as the triangle, and pivotally united to it by the parallel links *a*, *a*, and the

screws *s*, *s*, *s*, *s*. *B* is a cam-shaped gage, which is also pivotally united to the triangle by the screw *b*. This gage overlaps the piece *A*, which carries a pin *c*. This pin engages in the curved groove or opening in *B*. The opening in *B* gradually widens from one end to the other, and the position of the gage determines the throw of the instrument when it is set to regulate the distance between lines. Figures 2 and 3 illustrate extreme positions of the gage. In the former the pin entirely fills up the opening, and there is no throw to the instrument, while in the latter the throw is a maximum.

"In operating the section liner it is desirable to place the lower edge of the triangle in contact with the blade of the T-square in order to correct any tendency it may have to twist out of position. In covering small areas, however, this is unnecessary.

"The right-hand edge of the groove bears against the pin *c*, as shown in Figure 1, and a line is ruled along the long edge of the triangle. The piece *A* is then moved to the left until the pin strikes against the left-hand edge of the groove. The triangle is then moved to the left

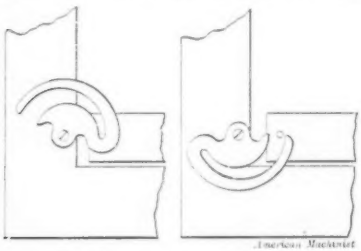


Fig. 2 *Fig. 3*

until the pin bears against the right-hand edge of the groove, thus regulating the space between the lines. The second line is ruled and the operation repeated.

"The perpendicular edge of the triangle may also be employed if required by moving the triangle from left to right, instead of from right to left, as above described.

"In moving the triangle the finger should be placed on the piece *A* to prevent it from slipping, and in moving the piece *A* the finger should be placed on the triangle for the same reason. The holes *c c*, which are bored into the triangle and piece *A*, are designed to receive the tips of the fingers, which may remain in these positions while the instrument is in use, one finger sliding one piece into a new position, while the other finger holds the other piece firmly against the paper.

"It will be seen that the width of the spacing may be increased indefinitely beyond the limits controlled by the gage by omitting one or more lines."

As no intimation is given that the attachment has been patented or placed on sale, it is presumably free to be used by any draughtsman who desires to do so; and it is so simple that almost any one will be able to construct it and attach it to a triangle.

Boiler Insurance Inspection.

OUR excellent contemporary, *The Safety Valve*, has commenced a campaign directed to securing improvement in systems of boiler inspection and insurance. In furtherance of this commendable purpose it has been giving liberal and well-prepared abstracts of laws of various countries regulating the use of boilers and editorially and otherwise presenting much which bears directly upon this important subject. An abstract of a report made by Mr. E. G. Hiller to the National Boiler Insurance Company, England, on Boiler Insurance Inspection in England, continued from the August number of the same journal and which is entitled "Insurance Inspection During the Construction of New Boilers," is printed in the issue of Sept. 15 and is a valuable paper worthy the careful and thoughtful perusal of every one interested in the use of steam boilers for power purposes. Mr. Hiller in his paper advocates the aid of insurance inspectors at the very outset of boiler building from specifications. He says with reference to this aid, that in England the National Boiler Insurance Company sends an inspector to attend "at the plate makers when the plates are rolled and mark the plates with the company's stamp, and also to mark pieces for shearing off to be tested for tensile strength and elongation. Thereafter the supervision of the inspector is continued at suitable stages of the work. The title should have been extended to include inspection after completion for this is also treated of in Mr. Hiller's valuable paper, and the details of this inspection are given

for which the reader must consult the article itself. Such a system of inspection would inevitably result in permanently advancing the art in the United States. The insurance inspection of boilers is not here frequently directed to the construction of boilers under construction from specifications, yet there appears to be no reason why this could not practically be carried out here as well as in England.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

The Machine Shop.

25014. A Remarkable Job of Broaching. Ill. (A M-Sept. 13.) 900 w.

25015. Makeshift Indexing. Ill. Oberlin Smith (A M-Sept. 13.) 1200 w.

25016. Chasing. Ill. John T. Usher (A M-Sept. 13.) 900 w.

25227. Tuyere Location. Herbert M. Ramp (A M-Sept. 20.) 1400 w.

25229. Heavy Quarter-turn Belt Drive. Ill. James F. Hobart (A M-Sept. 20.) 800 w.

25234. An Electro-Magnetic Clutch. Ill. (S V-Sept. 15.) 650 w.

25380. Chuck for Drill Grinding Machines. Ill. (Ir Age-Sept. 27.) 900 w.

25383. Hardened Rollers as Pressure Bearings. Ill. Oberlin Smith (A M-Sept. 27.) 1700 w.

25403 A Fluid-Pressure Reversing Gear for Locomotive Engines. Ill. David Joy (R G-Sept. 28.) 1800 w.

25527. A Paper of Pins. Ill. Fred H. Colvin (M A-Oct.) 1000 w.

25529. Draughting Room Practice. Walter B. Snow (M A-Oct.) 1500 w.

25531. On the Resistance of Trains of Mechanism. Ill. Leicester Allen (M A-Oct.) 1700 w.

25567. A Combination Section Liner and Triangle. Ill. F. R. Honey (A M-Oct 4.) 500 w.

25621.—$1.50. Friction Rollers. Ill. C. L. Crandall, with Discussion (T C E-Aug.) 8500 w.

*25680. The Friction Clutch in Theory and Practice. Ralph D. Mershon (E-Sept. 28.) 2500 w.

Steam Engineering.

*24950. Why Some Men Fail as Steam Engineers. W. H. Wakeman (E Mag-Nov.) 3000 w.

24984. An Economical Mill Engine.—The Highest Economy on Record for Mill Work. Ill. (B J C-Sept. 8.) 1200 w.

24985. Burning Small Sizes of Coal.—How It Should Be Done (B J C-Sept. 8.) 1400 w.

25012. Allis Steam Engines, Oiling System and Subsidiary Apparatus in the Eastern Power House of the Brooklyn City Railroad Company (Sc A-Sept. 15.) 900 w.

25102. Hot vs. Cold Cylinder Walls (B J C-Sept, 15.) 1200 w.

25233. The Safety of Steam Boilers and Other Considerations. John MacCormack (S V-Sept. 15.) 1300 w.

25235. Insurance Inspection During the Construction of New Boilers. (Abstract.) E. G. Hiller (S V-Sept. 15.) 1400 w.

*25240. Utility of Exhaust Steam. Leicester Allen (D E-Sept.) 1100 w.

25243. Throttling vs. Automatic Engines. W. H. Wakeman (M A-Sept.) 2300 w.

*25272. Liquefaction in Steam Cylinders. Editorial (Eng L-Sept. 14.) 1400 w.

*25274. The Heating Value of Coals. Walter J. May (C G-Sept. 14.) 1000 w.

25304. Indicator Errors. Correction in Accurate Measurement of Power (B J C-Sept. 22.) 1500 w.

25305. Hunting of Engine Governors.—Causes and Remedies Therefor (B J C-Sept. 22.) 1500 w.

*25319. Some Notes on the Governing of Steam Engines Particularly when Coupled to Dynamos. G. L. Addenbrooke (El-Sept. 14.) 2000 w.

*25365. Engine Cylinder Clearances and Initial Condensation. Ill. Michael Longridge (P Eng-Sept. 14.) 2400 w.

25513. Temperature of Cylinder Walls (R R-Sept. 29.) 3000 w.

*25540. The Corrosion of Boilers and Steamships. C. Ward (P Eng-Sept. 21.) 4600 w.

25559. Boiler Inspection Laws of Germany (S V-Sept. 15.) 1300 w.

25582. Hand-Hole Guards. Ill. (M G-Sept. 29.) 1300 w.

25583. Large Gas Engine Plants.—Are They More Economical Than Steam Plants? (B J C-Sept. 29.) 1300 w.

25585. On the Steam Jacket.—Conclusions Arrived at by Professor Thurston (B J C-Sept. 29.) 500 w.

25709. Some Diagrams from a Brown Engine.—Cause of Loop at Steam Line (B J C-Oct. 6.) 400 w.

25710. Testing Indicators (B J C-Oct. 6.) 1800 w.

25754. The Injector. Ill. Albert E. Edkins (C E N-Oct.) 2500 w.

Miscellany.

24983. Elasticity of Machinery (B J C-Sept. 8.) 700 w.

25031.—$1.50. Notes on Wire Tramways. Ill. A. C. Savage (T C E-July.) 2000 w.

We supply copies of these articles. See introductory.

25032.—$1.50. Steam and Electric Cableways for Logging and Canal-Boat Towing. Ill. Richard Lamb (T C E-July.) 2700 w.

25074. Countries Where Piracy of Inventions is Legalized. George G. Turri (I Age-Sept.) 1600 w.

25075. Nature and Policy of Letters Patent for Inventions. Levin H. Campbell (I Age-Sept.) 1800 w.

*25121. Mechanics as a Fine Art. William T. Magruder (E A S-Aug.) 2800 w.

25164. The Prospects of the Gas Engine. J. H. Killey (C Eng-Sept.) 1000 w.

25188. Successful Managers. C. R. Tompkins (A S-Sept. 15.) 900 w.

25230. A Note on Compressed Air. Frank Richards (A M-Sept. 20.) 4300 w.

*25275. Qualities Necessary in Manufacturing Coal. M. Schmidt (C G-Sept. 14.) 3000 w.

25306. Compressed Air for Transmission of Power. Editorial (B J C-Sept. 22.) 800 w.

*25368. Machinery in Court.—The Part Which It Plays as Evidence in Actions (M-Sept. 15.) 1600 w.

*25475. A New Mechanical Fluid (Inv-Sept. 22.) 1500 w.

25526. Sixty Years a Mechanic. — Some Reminiscences of an Old Workman. Joshua Stevens (M A-Oct.) 1300 w.

†25545. The First United States Pneumatic Postal System. A Faikenau, with Discussion. Ill. (P E C P-April-June.) 6000 w.

25566. Some Unusual Movements. Ill. C. L. Redfield (A M-Oct. 4.) 800 w.

24584. Petroleum as a Lubricant.—Its Value and How to Test It (B J C-Sept. 29.) 900 w.

25593. Cost of Power from Prime Movers. G. G. Hiscox (Pr-Oct.) 2400 w.

25604. An Important Prospective Patent Decision. Charles A. Brown (E E-Oct.) 1600 w.

25620. The Long-Running Meteorograph of the Mont Blanc Observatory. Ill. J. Janssen (Sc A-Oct.) 800 w.

25626.—$1.50. The Pulp Mill of the Cliff Paper Company of Niagara Falls, N. Y. Ill. Wallace C. Johnson (T C E-Aug.) 4800 w.

*25667. The History and Development of the Gas Engine. (Abstract) W. Norris (J G L-Sept. 25.) 2000 w.

25718. Superiority of American Machinery (M G-Oct. 6.) 1200 w.

*25725. American Trade Schools. Ill. (I C B-Sept. 28.) 500 w.

*25749. The Motion of a Wheel. Ill. Herbert Aughtie (P Eng-Sept. 28.) 700 w.

Serials.

13534. The Gas Engine (M W-Began June 2, 1893—11 parts to date—30 cts. each).

16781. Rope Driving. J. J. Flather (E W-Began Oct. 26, 1893—12 parts to date—15 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (El-Began Dec. 1—22 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Ill. Albrecht von Ihering (E M-Began Feb.—8 parts to date—30 cts. each).

19709. The Indicator and Its Diagrams. Charles Day (P Eng-Began Feb. 2—17 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E-Began March—8 parts to date—30 cts. each).

21141. High Speed Steam Engines. John Radinger (E M-Began April—7 parts to date—30 cts. each).

23639. Mechanical Draught (E R L-Began July 6—2 parts to date—30 cts. each).

23826. Comparison of Different Formulæ for Dimensions of Parts of Steam Engines. William Kent (A M-Began July 26—4 parts to date—15 cts. each).

24038. Compressed Air.—The Problem of Transmitting Power to Long Distances by Its Use. Ill. (C E-Began Aug.—Ended Oct.—3 parts—30 cts. each).

24338. Gas Engines. David Salomons (P A-Began Aug. 15—3 parts to date—15 cts. each).

24722. Methods of Determining the Dryness of Steam. W. C. Unwin (Eng L-Began Aug. 24—Ended Sept. 7—3 parts—30 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (E L-Began Aug. 31—4 parts to date—30 cts. each).

25100. Oil Engines. Ill. William Stafford (P Eng-Began Sept. 7—Ended Sept. 14—2 parts—30 cts. each).

25193. Electrical Machinist Practice. Ill. James F. Hobart (E E N Y-Began Sept. 19—3 parts to date—15 cts. each).

25381. The Walker Universal Tool and Cutter Grinder. Ill. (A M-Began Sept. 27—2 parts to date—15 cts. each).

25469. Type-Writing Machines. Henry Charles Jenkins (J S A-Began Sept. 21—2 parts to date—30 cts. each).

25528. The Design and Construction of Modern Steam Engines. Theodore F. Scheffler, Jr. (M A-Began Oct.—1 part to date—15 cts).

25538. Testing of Engines and Boilers. Ill. Charles Day (P Eng-Began Sept. 21—2 parts to date—30 cts. each).

25563. Spacing Holes.—Easy Way (A M-Began Oct. 4—1 part to date—15 cts).

25611. Calculation of a Compressed Air Transmission when the Subsidiary Losses of Energy are Taken into Account. From Professor Unwin's "Development and Transmission of Power" (E M-Began Oct.—1 part to date—30 cts).

25735. Notes on the Steam Turbine. Kenelm Edgcumbe (E R L-Began Sept. 28—1 part to date—30 cts).

MINING & METALLURGY

The Genesis of Ore Deposits.*

FEW contributions to the science of economic geology have attracted such attention as Prof. F. Posepny's monograph on "The Genesis of Ore Deposits," presented at the Chicago meeting of the American Institute of Mining Engineers, in August, 1893. The discussion of that paper was continued at the February meeting, and now again at the October meeting at Bridgeport, besides many communications to the mining and geological periodicals, and has elicited much fresh evidence and a variety of professional opinions. Professor Posepny now replies to his critics *seriatim*, and amplifies and further explains the conclusions previously announced by him, dwelling especially upon the conditions of underground water circulation, as bearing upon the much-vexed question of ore deposition by lateral secretion *versus* the ascensional theory. The author re-states his position in favor of the latter theory as the more probable and more generally applicable explanation, giving his evidence therefor, and drawing his deductions in a manner admirably conscientious and free from the slightest taint of dogmatism. It may be remarked here that in the narrow sense in which the lateral-secretion theory of Professor Sandberger was first announced, attributing the sources of ore bodies to the immediate wall rocks, it presented obvious difficulties and for some cases inconceivable conditions, and has latterly been modified and widened, to refer the sources of ore to rocks within "reasonable proximity," with much latitude as to the local direction of the solvent and precipitating currents; so that it has lost much of its precision, and, while offering a more satisfactory general explanation, has somewhat fallen from the dignity of a clean-cut theory. Another point developed in the course of the argument is the manner of deposition of ore and vein matter, whether by successive fillings of open cavities (that is, pre-existing spaces filled only with air or water) or by molecular substitution (also termed "replacement" and "metasomasis"). Professor Posepny regards "crustification"—a more precise term than "banded structure"—as a clear proof and test of deposition in open fissures, caves, vugs, etc.; but does not exclude the metasomatic origin of deposits preserving the structure of the original mass, as sometimes plainly shown. To Professor Posepny's latest utterance Dr. R. W. Raymond has appended a summary of the argument, with comments of his own.

*The subject-matter of this and of the four following notices is contained in papers presented at the Bridgeport meeting of the American Institute of Mining Engineers, October, 1894; and the comments upon these papers are based upon advance sheets of the *Transactions Am. Inst. Mg. Engineers* for the current year.

Ore Dressing in Sweden.

METHODS of preparing ore for reduction or for the market in Sweden are described in detail by Mr. P. G. Lidner, with separate accounts of representative works. In that country the mechanical concentration of ores has not attained any considerable extent quantitatively, by reason of the scarcity of ores calling for this kind of treatment, these being limited, with one exception (at the Sala mine, producing argentiferous galena and other silver-bearing minerals), to blende, or blende and galena intimately mixed. But the works are extremely interesting because of the very difficult nature of the material treated, which is of low grade carrying the valuable minerals mostly in a state of very minute subdivision. In the main, the apparatus and methods resemble those of the German plants, the system involving a close sizing and classification of material, separate treatment of the differ-

ent classes and sizes by machines especially adapted for each, with a complication of regrindings, resizings, hydraulic classifying, and re-concentration, with the ultimate result of very clean products, the separation of blende from galena being very perfect. The losses in concentration are unavoidably high, owing to the character of the material, which does not lend itself readily to mechanical concentration, and range from 21 up to even 50 per cent. on the finely disseminated blende and galena mixed ores. The advocates of close sizing will find, in the examples described, model plants with numerous sizing drums, ore classes, subdivisions and re-treatment; but the author leaves it to the reader to form an opinion whether the same results could not be obtained in a simpler way and by a less complex system. As to the careful preparatory work of sorting and hand-culling, which deserves attention because it effects a greater saving than is generally supposed, Mr. Lidner does not recommend in American practice the carrying of hand-work so far as in Europe, because wages are higher; but believes that this preliminary operation is too much neglected in the United States, and that many concentrating works, especially in the zinc-mining districts, would profit by paying more attention to it. In Sweden the cheapest labor is employed for the sorting; on the picked, clean ore there is no loss in concentration; there is no wear and tear of machinery by anything thus removed, be it clean mineral or gangue; and both the machinery and the mill work are highly benefited by keeping out broken tools, pieces of iron or wood, rags, etc. A special feature of some Swedish works is the light kiln-roasting of some ores containing worthless pyrite, to eliminate that mineral from the concentration problem where the product of the works is to be pure oxides.

Inaccuracy of the Silver Assay.

WITH the object of convincing the managers of silver mills that the customary calculations in regard to the percentage of silver saved are misleading and often far from the truth, Mr. C. A. Stetefeldt presents a paper on the inaccuracy of the commercial assay for silver, and of metallurgical statistics in silver mills, with special reference to the treatment of roasted ores by amalgamation and lixiviation. Besides the known errors of the commercial fire assay, from silver remaining in the slag, absorbed by the cupel, and volatilized in the crucible melting, scorification or cupellation, there are errors from incorrect sampling and in the weighing of buttons. The losses in slag or by absorption may be ascertained with practical accuracy by reassaying the slag and cupel, and adding the result to that of the button, thus obtaining a "corrected" assay. The loss by volatilization is an unknown quantity, the author thinks, which cannot be ascertained even by synthetic methods. Recent researches however have thrown considerable light upon this question. Mr. Stetefeldt tabulates the results of numerous assays at different mills, by different assayers, and brings out some remarkable discrepancies between the commercial and the corrected assays. The latter are the highest returns obtainable in ordinary practice and without specially refined methods, but as the former (the commercial assays) are commonly taken as a basis in reporting percentages of silver saved and lost in actual treatment, the apparent results may evidently be far astray. What the author charges against the common practice in mill work of course holds good as to smelting, though at smelting establishments the sampling and assaying are performed with greater care.

Manganese Slags at Tombstone, Arizona.

THESE form the subject of a communication by Mr. John A. Church, in which he records the results of smelting concentrates from silver ores, using low-grade argentiferous manganese ore as a substitute for iron flux. The material treated was extremely unpromising, the difficulty of making a smelting product from slimes containing only three per cent. of lead being only the first of many obstacles to be faced. At the time no smelter had ventured to trust manganese as a precipitant, though large quantities of mangan-

ese ore containing silver were bought and used by smelters (as at Butte), who then looked upon manganese solely as a basic flux for silica. On the whole the results of all the runs (1307 days, with 41,626 tons smelted) were fairly satisfactory and certainly formed a unique chapter in the history of smelting. Although silver-lead smelting is now on a different footing from what it was in 1882-86, when the plant at Tombstone was running, and the conditions of transportation and smelting charges have changed, the experience then gained is still instructive.

Does the Vibration of Stamp Stems Change their Molecular Structure?

THE controversy over the question of the crystalization of iron and steel by vibration and repeated shocks, or rather as to the validity of that theory as an explanation of the breakage of stamp stems, is by no means yet settled. Messrs. Argall and Austin on the affirmative and Dr. Raymond on the negative stoutly maintain the battle, with extended argument, observations and reference to authorities. By common consent the question has been narrowed down to the concrete case of the battery stems, or in other words to the causes of the breakage of wrought iron and specially worked mild steel under limiting conditions, in the cold and under specified stresses. It is hardly necessary to say that the argument has been conducted with much keenness and ingenuity on both sides. To attempt to recapitulate or summarize it with the space available here would be to do injustice to the able contestants and would present a very imperfect view of the case to the reader, who must be referred to the entire debate in the *Transactions*. But as the question is of far-reaching importance in the whole metallurgy and use of iron and steel, and perhaps of other metals also, it may be well to quote the tests proposed by Dr. Raymond, any one of which would prove a good deal: (1) Let a stamp stem which has been running for a long time without breaking be taken down and examined as to fracture and structure; (2) to make this result conclusive, let a comparison be made between such a stem and one made at the same time from the same metal, but not used; (3) let a stem which has broken in service be examined as to its structure at other points than that of fracture; (4) let such a stem be tested to ascertain whether, at any point in it, it is not possible to produce at will either granular or fibrous fracture by simply varying the means and method of fracture; (5) let any stem, new or old, used or unused, be tested in the foregoing manner. It might be supposed that the behavior of stamp stems in actual service would in itself offer conclusive testimony; but a careful examination of the arguments and facts shows that there is something still to be said on either side, and that only systematic tests will be convincing to all.

Does Iron Crystallize in Service?

LOOSE use of terms creates confusion of thought and often leads to needless controversy where the issue is not so much one of fact as of definition. For example, here is the discussion over the question of crystallization of iron and steel in service. Mr. P. Kreutzpointner clears away some of the misconceptions by drawing a sharp distinction between the words "crystalline" and "granular" and defining "fibrous" as applied to these metals, which he does in a carefully prepared article in the *Iron Age*. It has been shown that the best soft iron is liable to break with a "crystalline" fracture under certain conditions, thus giving the impression that it had turned crystalline from its original fibrous state. But now for the definition:

> A fracture is crystalline only when the shining particles are formed with more or less well developed angles bearing the characteristics of crystallization. But there are many fractures of iron and steel which present shiny facets, it is true, but are nothing else than the transverse section of the "fiber" or crushed original crystal which formed while the fluid or semi-fluid mass was slowly cooling and was subsequently rolled out or hammered down and elongated. . . . These elongated crystals cannot be properly called crystals any longer, and hence the fracture . . . exhibiting the transverse section of these [former] crystals in the form of a shiny angular surface is more properly termed

granular. But to many . . . a granular fracture is crystalline in appearance because of the similarity, and they jump to the conclusion that the iron or steel crystalized in service.

This deceptive appearance is well shown by an illustration in the *Iron Age* article of a bar broken short off and having across the end a very marked granular fracture with bright facets, but a longitudinal slice through the middle of the bar proves that these facets are merely the ends of rolled out crystals, that is, "fibers." This sort of fracture is produced by very sudden rupture, when the particles have not time to flow and rearrange themselves. None of the disputants deny that metals are subject to "fatigue" under repeated stresses; but this admits of various explanations. "Fatigue" is a convenient word, which does not tie the user down to any theory.

Curvature of Diamond Drill Holes.

IT often happens in prospecting by means of the diamond drill, when the holes are drilled in any direction other than vertical, that false indications are given as to depth and distance. Mr. J. Parke Channing, who has been investigating this source of error, has communicated his results to the Lake Superior Mining Institute, and his paper is reproduced in the *Engineering and Mining Journal*. While drilling a series of fan holes to test the formation on one of the Michigan ranges Mr. Channing found that cores from holes started downward at an angle of 45° did not correspond with the calculated stratification at the supposed position of the bottoms of the holes. Concluding that the angle must have changed, he proceeded to test this by the method of lowering glass tubes containing hydrofluoric acid and noting the angle of the etched ring. The first trial, not wholly conclusive, indicated that at a depth of 531 feet the hole had flattened 15°. After experiencing trouble with different forms of apparatus, the results being vitiated by the hydraulic pressure driving stoppers in and compressing the air, or forcing in water through the plugs and diluting the hydrofluoric acid solution, successive experiments giving no test, Mr. Channing had special tubes made, 1 inch in diameter, 5 feet long, with ground glass stoppers. These also failed at first, the water working in through the ground joint. The final and successful method was, in brief, as follows: The vacant end of the core barrel was plugged tightly with wood; the upper end of the tube warmed and the stopper heated in a little paraffine; the tube placed vertically; 1 inch of 20° acid carefully poured in, then 1 inch of water; the stopper fitted in; the tube, still vertical, was put in the core shell and the latter screwed into the barrel. The apparatus was then lowered with the rods, care being taken to touch the bottom of the hole gently. Experiments as to the time necessary to leave the tube in the hole showed that two hours were as good as twenty-four, but that one hour was insufficient. The angle of etching was read by clinometer. It was also proved that the rods would turn freely with considerable curvature.

In some of the deep holes the point was 60 feet higher and 50 feet farther than if drilled straight. Lateral deviation could not be tested by a tripped compass, on account of local irregularities of attraction. The cause of the holes flattening was found to be that with a new bit on an old core barrel the upper end of the latter had an extra clearance and tended to press down, thus gradually raising the direction of boring.

Electric Smelting of Iron.

THE possible application of the Taussig electric smelting process in certain parts of the southern United States is discussed in the *Manufacturers' Record* by a writer who holds rather sanguine views as to the success of that method. After alluding to the introduction of electricity into other branches of metallurgy (as in the production of aluminum, welding, etc.), the experiments of Edward Taussig, of Bahrenfeld, Germany, are described. The process has attracted much comment in the technical press but has not yet been introduced on a commercial scale, though one plant is being erected at Copenhagen and another in the south of France. It consists in first

reducing and smelting the ore, with suitable flux, and finally in casting the metal thus produced. The apparatus consists of a long air-tight smelting chamber in which the hearth inclines toward a central opening through which the metal passes into the mold. The furnace is lined with glazed firebrick. As no carbon is present the metal is "almost pure" and the rarefied atmosphere (also described as a "vacuum") "removes any gases produced, prevents oxidation or blistering, and increases the fluidity of the metal, thus producing castings which are dense and homogeneous." If steam is to be used to run the dynamo, the writer claims a large economy of fuel as compared with other smelting methods; but more conservatively explains that the most advantageous application of the process would be in places where ores exist near to some available water power or where fuel is high-priced and water-power can be transmitted without too great loss. It is also suggested that an electric generating plant might be erected near coal mines and power obtained by using slack coal in producers, heating the boilers with the gas, and transmitting the current from the dynamos to electric smelting furnaces at the iron mines. The author of the paper considers that if full success is attained in the European plants the south would be an exceptional field for the process, owing to the numerous water-powers at hand. He enters into details as to cost and results, which have already been widely published, and appears to be more hopeful than the many metallurgists who consider the electric smelting of iron ores to be a little ahead of the times, however promising it may seem as a method for the indefinite future to develop.

Natural Gas in Indiana.

THE full text of the last report of Mr. Jordan, inspector of natural gas for the state of Indiana, is quoted in the *American Gas Light Journal*. Occasion has been taken in a previous issue of THE ENGINEERING MAGAZINE to refer to the yeoman's service rendered by this active officer in striving to check the waste of natural gas and to prolong its usefulness as far as this can be accomplished by measures adopted at this late day. It is known, from bitter experience, that the stock of natural gas in any area (and the productive areas are limited) is a rapidly exhaustible quantity, and that if, as is doubtful, gas is being generated at present, it is in quantities insignificant in comparison with the enormous drain both for consumption and through wastage. In Indiana the failure has begun, as is shown by the great reduction in pressure; while in parts of Pennsylvania and Ohio the exhaustion is already complete. Considering the vast investments in manufactories dependent on natural gas, the question is a most serious one. Mr. Jordan says:

> The gravity of the situation can only be understood when it is known that from 225 to 250 pounds pressure at the head of the main lines is absolutely necessary to force the gas to the different cities that lie outside but are obtaining their fuel from the gas field, with sufficient pressure to distribute it through the low-pressure city lines to the consumer. . . There remains now but a small average margin above the limit of low pressure. At the annual rate of reduction, and by a continuance of the present extravagant and wasteful method of consumption, this small margin will be spent . . in a very short time. When this shall have happened, artificial pressure by means of pumps will be resorted to. . . It has been the experience of other states that when the initial pressure must be supplemented by artificial means the end is very near at hand. A careful study of the conditions of the field in Indiana as they exist to-day will show that we have almost reached that point.

As remedies, Mr. Jordan offers the following common-sense suggestions: (1) All gas should be sold by meter measurement, and this should be enforced by law; (2) natural gas should not be used in the manufacture of bricks, tiles, nor in the rolling mills nor melting furnaces of glass factories. In these works a coarser and less valuable fuel can be used. The inspector rightly adds that the highest and best purpose to which natural gas can be applied is the domestic use. It is in this use that it does the greatest good to the greatest number, and it is for this use that it should be preserved.

Mining Experts.

MUCH has been said, written and printed about the qualifications, functions and responsibilities of mining experts, but there always seems to be room for a last word, and this the *Mining Journal* now utters. Recent occurrences in South Africa, and possibly in the new gold fields of West Australia, cause the *Journal* to take up the subject anew and call the attention of English investors to some of the aspects of the situation. When mining properties are offered upon the market, a very grave responsibility rests upon the experts sent out to examine and report upon them. This is strongly felt by a man who knows that a favorable opinion by him will probably entail a heavy expenditure on the part of his clients. In addition to the technical training, practical experience and business acumen necessary to the real expert, there is obviously demanded a quality independent of these—a moral sense and integrity that will inspire confidence and be a guarantee not only of good professional judgment but of good faith. The *Journal* is quite right in insisting that only the best and most reliable of men should be chosen for work of this sort; men fully alive to the responsibilities involved. Much saving of money and the diminution of mining failures would have resulted from better selection of experts. "Unfortunately," remarks our contemporary, "during the rush and excitement due to the discovery of a new and rich gold field, ordinary business precautions seem to be neglected and the statements of unknown men are accepted as being absolutely true, while the necessity of their confirmation is lost sight of." Afterward the investors find out their mistake. It might be added that it is always easy to get the professional rating of any man who sets up as an "expert."

A suggestion that we do not remember having seen put forward in print before is offered by the *Mining Journal*—namely, that instead of sending in his report, the expert should if possible submit it in person and be cross-examined thereon by his employers, for there are many points which may be omitted from a written report upon which his views and opinions, as one who has been on the spot, would be valuable. Apropos of the form and weight of reports the *Journal* might cite as an instance of a very convincing sort the story of the American expert who returned from making an examination and said to his client, drawing out his check for $5000: "That is all the report I need make. Let me into the deal."

Regarding mine salting, the *Mining Journal* perhaps lays too much stress upon the danger; but concedes that in the majority of cases the vendors are honest in their dealings, though of course anxious to make the most favorable terms. A more common trouble the expert has to encounter is the overestimate that holders always have and the partiality of all neighbors to put the best face upon matters concerning which testimony rather than observation has to be relied on. So far as personal examination goes, sampling, when properly and conscientiously done, is more accurate than our contemporary is inclined to believe. This can readily be put to the test of a trial mill run or sale of ore to a smelter, and of course the expert will resort to these larger metallurgical tests whenever the transaction is of importance.

Finally, as to fees: "The duties entrusted to a mining expert are about as onerous as can be confided to any one man, and we are decidedly of opinion that his fees, even though stiff, are well earned." As a percentage on the money involved they are disproportionately below the fees of architects and civil engineers; besides, the mining expert has to charge for much lost or unoccupied time. The value of a negative report is not always appreciated by would-be investors.

AMERICAN coal, says *Black Diamond*, has possession of the Havana market, to the nearly total exclusion of English, but in Jamaica the English fuel is used far more than the American. The ascendency of American coal in Cuba is a commercial victory, and the conditions in other parts of the West Indies and in portions of South America are substantially the same as in Cuba.

PROGRESS in electric mine-hoists is shown by a two-motor, double-reel hoist described and illustrated in the *Mining and Scientific Press*. Each motor is of 500 horse-power; combined, 1000 horse-power. The reels are for flat steel cables, and the hoist is designed to raise a load of 5 net tons from a depth of 2500 feet in one minute. This is probably one of the most complete hoists yet made.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Metallurgy.

*24949. Present Status of the Nickel Industry. William L. Austin (E Mag–Nov.) 3000 w.

25071. The Taussig Electrical Smelting Process and Its Possible Utilization in the South (M R–Sept. 14.) 1100 w.

*25102. Tin Plate Manufacture. South Wales vs. America (I & S–Sept. 8.) 900 w.

25173. The Fairfield Copper Company. Maurice Barnett (E M J–Sept. 15.) 1800 w.

25174. Experiments with Zinc Ores in a Blast Furnace. H. Hunicke (E M J–Sept 15. 900 w.

25213. Iron and Steel Statistics for 1893 (E N–Sept. 20.) 1100 w.

*85342. The Principles of Jigging. Editorial (M J–Sept. 15.) 2500 w.

25378. Do Iron and Steel Crystallize in Service? Paul Kreuzpointner (Ir Age–Sept. 27.) 1800 w.

25416. The Murphy Gold Process. J. G. Murphy (M S P–Sept. 22.) 3000 w.

†25432. Solids Falling in a Medium. F. M. F. Cazin (Tr A M E–Oct.) 3500 w.

†25433. Close Sizing before Jigging. Ill. Robert H. Richards (Tr A M E–Feb.) 8400 w.

†25434. Aluminum-Bronze. Leonard Waldo (Tr A M E–Feb.) 1500 w.

†25438. Magnesia and Sulphur in Blast-Furnace Cinder. Frank Firmstone (Tr A M E–Oct.) 1300 w.

†25439. A Uniform Method for the Assay of Copper—Materials for Gold and Silver. Albert R. Ledoux (Tr A M E–Oct.) 2600 w.

†25440. The Inaccuracy of the Commercial Assay for Silver, and of Metallurgical Statistics in Silver-Mills, With Special Reference to the Treatment of Roasted Ores by Amalgamation and by the Russell Process. C. A. Stetefeldt (Tr A M E–Oct.) 2500 w.

†25441. Does the Vibration of Stamp-Stems Change Their Molecular Structure? Continued Discussions of Mr. Rickard's paper "The Limitations of the Gold Stamp Mill" (Tr A M E–Oct.) 5500 w.

†25442. The Manganese Slags of Tombstone, Arizona. John A. Church (Tr A M E–Oct.) 2500 w.

†25444. Ore-Dressing and Concentration in Sweden. P. G. Lidner (Tr A M E–Oct.) 4800 w.

*25472. The Bessemer Steel Industry and the Nail Manufacture. Ill. Henry Bessemer (E Rev–Sept. 20.) 1100 w.

*25486. Bell-Founding (I C B–Sept. 21.) 2000 w.

25530. Forty-five Tests of Malleable Iron. Ill. George L. Fowler (M A–Oct.) 1500 w.

†25551. The Detection and Approximative Estimation of Minute Quantities of Arsenic in Copper. F. A. Gooch and H. P. Moseley (A J S–Oct.) 1200 w.

*25574. Improvements in the Cyanide Process. Editorial (M J–Sept. 22.) 1200 w.

25629. Are Iron and Steel Crystallized by Vibration? (E N–Oct. 4.) 3000 w.

*25685. The Cowper-Cole's Galvanizing Process. Ill. (Eng L–Sept. 28.) 2800 w.

25712. The Blast Furnace. E. C. Potter (I T R–Oct. 4.) 2600 w.

*25728. A New Method of Smelting Pyritic Ores (Inv–Sept. 29.) 2200 w.

Mining.

*24953. The World's Production of Gold. T. A. Rickard (E Mag–Nov.) 3000 w.

24956. The Malacate Silver and Gold Mines of Sultepec, Mexico. Edward Halse (E M J–Sept. 8.) 2100 w.

24957. Coal Mining in Iowa. G. A. Davis (E M J–Sept. 8.) 1200 w.

24964. Electricity and Mining. Editorial (B D–Sept. 8.) 1000 w.

24987. Natural Gas in Indiana During 1893—Report of Mr. Jordan (A G L J–Sept. 10.) 5200 w.

*25063. Cableways for Quarries. Ill. Spencer Miller (S–Sept.) 3000 w.

†25083. Rubber Hose for Hydraulic Placer Mining. Albert Williams, Jr. (I R W–Sept. 15.) 2800 w.

*25112. A Bold Mining Engineering Work.—Enterprise in the United States. Ill. (M J–Sept. 8.) 2800 w.

*25113. Explosions in Nova Scotian Coal Mines. Edwin Gilpin, Jr. (M J–Sept. 8.) 4200 w.

*25114. On the Origin of Gold in Quartz Veins. Henry Louis (M J–Sept. 8.) 3000 w.

*25115. Mining Experts. Editorial (M J–Sept. 8.) 1200 w.

*25120. The Mining Interests of Nova Scotia. Frank Cowley (E A S–Aug.) 3300 w.

*25130. The Law as to the Removal of Mining Fixtures and Machinery (C G–Sept. 7.) 5000 w.

†25145. English Money in American Mines. A Practical Miner (W R–Sept.) 3500 w

We supply copies of these articles. See introductory.

25171. A. Walrath et al. vs. Champion Mining Company, with Editorial (E M J-Sept. 15.) 5000 w.

25223. On the Chemistry of Coal Formation. J. W. Thomas (Sc A S-Sept. 22.) 2200 w.

*25325. The Coal Industry of India (B T J-Sept.) 1000 w.

25336. Curvature of Diamond Drill Holes. (Abstract) J. Parke Channing (E M J-Sept. 22.) 1200 w.

25339. The Prevention of Mine Litigation. Francis F. Freeland, with Editorial (E M J-Sept. 22.) 1600 w.

*25340 Colorado's Gold Resources (M J-Sept. 15.) 2500 w.

†25362. Stone Burning. F. J. E. Spring (I E-Aug. 25.) 800 w.

†25435. The Structure of the Richmond Coal-Basin. Ill. E. J. Schmitz (Tr A M E-Oct.) 3000 w.

†25436. The Geological Structure of the Ringwood Iron Mines, New Jersey. Ill. Frank L. Nason (Tr A M E-Oct.) 4000 w.

†25437. The Ore-Deposits of Butte City. R. G. Brown (Tr A M E-Oct.) 5500 w.

†25443. The Genesis of Ore Deposits. Continued Discussion of paper by Bergrath F. Posepny (Tr A M E-Oct.) 1400 w.

*25446. Explosions from Coal-Dust in Mines. Editorial (E-Sept. 21.) 3300 w.

*25452. The Iron Industry of European Russia. Hugh O'Beirne (C G-Sept. 21.) 5700 w.

*25457. The New Primrose Gold Mine. Ill. (I & I-Sept. 21.) 3300 w.

25464. Waste of Coal in Mining. Selwyn M. Taylor (A M & I W-Sept. 28.) 1800 w.

*25470. Production of Manganese Ore in the Caucasus (J S A-Sept. 21.) 1000 w.

25502. A Model Southern Coal Mine.—The Plan of Operations at the Soddy Coal Mines. R. A. Bowie (T-Oct. 1.) 900 w.

25636. "Desert" Mines of California. Ill. (M S P-Sept. 29.) 2500 w.

25638. The Nationalization of the Mineral Domain of Ontario. J. Bawden (C M R-Sept.) 5000 w.

25639. On Cage Conductors in Shafts. Ill. T. C. Hair (C M R-Sept.) 6000 w.

25640. The Colliery Fireman.—His Training, Treatment, Position and Duties. George Elce (C M R-Sept.) 3500 w.

25668. Cost of Coal Mining in Iowa. (Abstract) G. A. Davis (A M & I W-Oct. 5.) 1000 w.

*25686. The Boulonnais Coalfield. Marcel Bertrand (C G-Sept. 28.) 7700 w.

*25687. The Sydney Coalfield of Cape Breton, Nova Scotia. Hugh Fletcher (C G-Sept. 28.) 2200 w.

*25688. Lignites in Spain (C G-Sept. 28.) 1000 w.

25719. Leadville's Gold. Editorial (M I T-Oct. 4.) 900 w.

25722. Bridgeport Meeting of the American Institute of Mining Engineers, with President Fritz's Address (E M J-Oct. 6.) 8500 w.

Miscellany.

25641. Photography in Mines. Herbert W. Hughes (C M R-Sept.) 6500 w.

Serials.

20413. Mining Methods. Ill. (C E-Began March—8 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E-Began March—8 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E-Began March—8 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E-Began March—8 parts to date—30 cts. each).

21369. Press Working of Sheet Metals. Ill. Oberlin Smith (Ir Age-Began April 19—8 parts to date—30 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng-Began April 27—8 parts to date—30 cts. each).

22586. The Mineral Hydro-carbons. Henry G. Hanks (M S P-Began June 2—13 parts to date—15 cts. each).

22710. Science for Ironmongers (Irm-Began June 2—10 parts to date—30 cts. each).

24277. From Iron Ore to Steel.—A Sketch of Iron Mining and Manufacturing in Pictou County, Nova Scotia. Joseph Dix Fraser (C Eng-Began Aug.—Ended Sept.—2 parts—15 cts. each).

24362. Methods of Mine Timbering. Ill. (M S P-Began Aug. 11—4 parts to date—15 cts. each).

24802. Shaft Sinking and Equipment.—With Special Reference to Comparatively Shallow Basins. J. T. Beard (C E-Began Sept.—2 parts to date—30 cts. each).

24876. Methods of Mine Timbering. Ill. W. H. Storms (Sc A S-Began Sept. 8—4 parts to date—15 cts. each).

24918. The French Northern and Belgian Coalfield. Ill. Marcel Bertrand (C G-Began Aug. 31—2 parts to date—30 cts. each).

25277. Centrifugal Fans. (Abstract.) Paul Habets (C G-Began Sept. 14—2 parts to date—30 cts. each).

25337. Zinc Ore Separating Plant at Monteponi, Sardinia. Ill. (E M J-Began Sept. 22—2 parts to date—15 cts. each).

25384. Rustless Coatings for Iron and Steel. Ill. M. P. Wood (A M-Began Sept. 27—2 parts to date—15 cts. each).

25572. Mineral Resources of the United States. John Birkinbine (M J-Began Sept. 22—2 parts to date—30 cts. each).

25573. The Extraction of Copper from Alloys by Means of Electrolysis. Carl Schnabel (M J-Began Sept. 22—Ended Sept. 29—2 parts—30 cts. each).

25689. A Typical Gold Mine Region, Cripple Creek, Col. Ill. Arthur Lakes (C E-Began Oct.—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

Water Supply Engineering.

AN article written for *Technic*, by R. C. Gemmell and reprinted in *The Age of Steel* and several other publications, has deservedly attracted considerable attention on account of its very practical character. Of course it is quite impossible that a comprehensive treatise on water supply engineering could be compressed into the limits of a single newspaper or magazine article. What Mr. Gemmell has done is to place in plain array the practical points in construction whose neglect is sure to result in serious defects, if not practical or total failure. For an example of such failure arising from insufficient attention to the quality of puddle for reservoirs, an instance of failure to retain water in a new reservoir constructed for one of our large seaboard cities, and first filled during the past summer, might be cited—a failure that caused much disappointment, and loss to the contractor and delayed seriously a much needed addition of supply for the city alluded to.

Of clay puddle Mr. Gemmell says that "when properly made, it is nearly as valuable as concrete, but when carelessly made it may be worse than useless."

The materials used should be carefully selected, properly proportioned, and thoroughly compacted. If the compacting is done by ramming the surface of each layer should be deeply scored to make bond with the succeeding layer; if by rolling, a heavy grooved roller should be used. In the whole process of the design and construction of a reservoir the engineer should bear in mind the fact that "water abhors an angle," and should lose no opportunity to put one in its way wherever it is likely to try to force a passage out. The utmost care must be used to prevent the water following along the pipes in the entry trench, by enclosing them in masonry and building cut-off walls across them at intervals. Water is the most subtle enemy with which an engineer has to deal, and every precaution known to man must be taken to prevent its working through the embankment—even then the work may result in partial failure.

The article deals also with the testing of pipes, hydrants, gates, etc.; the proper location of street mains, with reference to the buildings to be supplied; the proper way to set hydrants; the inspection of pipes to determine existing imperfections; the depth to which trenches for pipes should be excavated; the proper method for laying pipes; pipe joints; pipe fittings; stand pipes for hydrants; size of connecting pipes for fire hydrants; excavations for and the proper setting of hydrants, etc., thus going over a subject that, while familiar to all trained hydraulic engineers, is one upon which municipal officers often need the precise kind of practical information, expressed in clear language with avoidance of technicalities, that Mr. Gemmell has given in this article. Especially is what he says about reservoir construction of value to city officials who, not being engineers, still desire to be able to form some reasonable judgment of the quality of water supply construction independently of the opinions of experts. This is not to say that any official not trained to engineering would, by reading Mr. Gemmell's paper, be able to dispense with expert advice in judging of the good or bad points in construction or repairs; but, that its perusal would, in very many cases, supply a kind of knowledge which would be very much better than the blank ignorance of the subject possessed by most city officials who get into office under existing systems of municipal government. It would at least enable them to suspect faults which often are entirely overlooked, and to intelligently guide their inquiries through the aid of experts.

Electrolysis Affecting Water Mains.

UNDER the title Mr. G. H. Benzenberg, of Milwaukee, presented to the recent convention of the American Water Works Association at Minneapolis a paper of unusual importance dealing with the recently ascertained destructive effect upon water mains that has followed the practice of connecting wires with underground mains or hydrants. The paper has been printed

under the heading, "The American Water Works Association" in *The Age of Steel;* and on account of its practical value has also been published and commented upon in many other engineering papers.

The true cause of the corrosion is found not to depend directly upon electric currents but to electrolysis of soluble salts existing in the earth surrounding the mains. The passage of the current through the mains sets up the decomposition of these salts—chlorides, nitrates, or sulphates of ammonia, soda, or potash, setting free their acids, which thereupon actively attack the iron pipes. A very interesting account of how his attention was first attracted to the subject through the bursting of a pipe in front of power house is given, but as this is not the most important part of the discussion, the reader is referred to the original paper for it.

The method of determining when and where the action is taking place, and its remedy, is, of course, what will be of greatest service to engineers. Mr. Benzenberg says "the water-works engineer can satisfy himself perfectly, whether his pipe is in danger or not, by purchasing a volt ammeter that will record a fiftieth part of a volt or ampere, and any of his men can, at the time they tap the main along the lines of a street railway, or occasionally with a hydrant, connect the same, one end with the water pipe and the other with the rail. If it indicates that the pipe is positive there is danger to the pipes.

"If the pipe shows it is negative to the rail there is no possible danger. The information can be easily and quickly obtained. It does not need an expert. A careful man, a tapper, or any one of the employés, except a common laborer, can keep on making these investigations and soon ascertain whether any part of the pipe is positive.

"As soon as it is indicated that the pipe is positive to the ground, further investigations should at once be made, first, as to whether the soil contains any of the soluble salts heretofore mentioned; and if it does, there is no question but what electrolysis is taking place and corrosion of the pipe is occurring at some point. There is no necessity of opening your trench to ascertain where this electrolysis is taking place; all it needs is to establish the proper equilibrium at that point between the pipe and the rail, by making a connection, with a good clamp and sufficient copper bond, between the pipe and the rail. At that point at least and for a long distance your pipe is immediately made negative and freed from all danger. It is surprising how quick the change takes place, and yet it is not surprising—because, as has been stated, the flow of the current is instantaneous; I have known where a tap had been made and the volt meter showed the pipe of five-tenths of a volt positive, sufficient to produce corrosion if the salts of the earth were of such a nature as to cause electrolytic action. A bond was placed around the pipe by my own man—keeping the volt ammeter in connection—and the moment the connection was made with the rail the pipe became negative."

Much other valuable information may be gained by a perusal of this excellent paper. For example the author does not advise the use of water mains as gronnd connections, yet he states that with proper precautions already indicated, 31 per cent. of the entire output of the power station at Minneapolis is returned through the water pipes without damage to the latter. The proper method of making the connection between the pipe and the rail to change the current from positive to negative is also described in detail. In dealing directly in the plainest possible manner with the subject in hand, and the avoidance of all superfluities, Mr. Benzenberg has supplied a model for engineering papers on practical subjects, which others may well imitate.

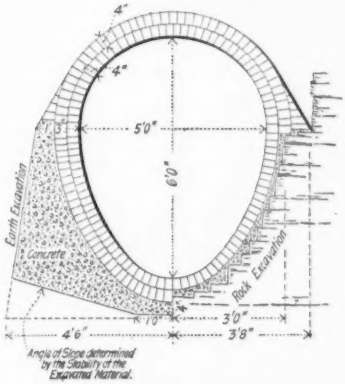
The West Side Trunk Sewer, Rochester, N. Y.

BECAUSE of some unusual features the sewer named in the title is attracting attention from engineering papers, and in *Engineering News*, an illustrated description of it is given. Our contemporary has kindly loaned the accompanying engravings for use in this review. Mr. Will. E.

Crane is the engineer in charge of the work.

The main trunk of the sewer, 17,700 feet in length, has lateral extensions aggregating 13,000 feet. The trunk sewer at the beginning is 5 feet in diameter (egg-shaped as shown by Figure 1) and increases to 6, 6¼, 8, 8½, 9 and 9¼ feet at the outlet. The minimum grade is 1 in 500 for about one-third of its length. The remaining length has its grades of 1 foot in 150 and 1 foot in 200. There are 1980 feet of 9½-feet tunnel. The sizes pass from egg-shaped to circular and thence to the horseshoe section. The outer shell is concrete rubble masonry to 1 foot above spring of arch, lined and arched with brick. The invert has one and two rings of brick imbedded in concrete to bed rock.

This one-sided rock excavation is one of the peculiarities of the work, and is made available to lessen the cost of the mason

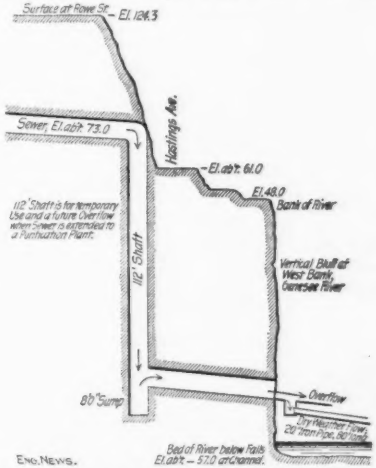


work lining, as well shown in figure. Of this feature the article under review speaks as follows:

This 4½ feet, egg-shaped portion of the lateral sewer (which sewer diminishes to 2½ feet in diameter) is designed to be similar in construction to that already described, with a two-ring brick arch and a two-ring invert when in earth, and one-ring invert in rock. The 5-feet section of the trunk sewer, has the same thickness of invert and arch. The 6¼ feet circular and egg-shaped sewer and all the larger sizes have concrete foundations, resting on 1-inch boards when not in rock. The 6¼ feet sewer has two rings of brick for the invert lining, and three rings for the arch, as do all the larger sewers, except when on a rock foundation or in tunnel. When on rock these larger sewers have but one ring of brick in the invert, except for one special section, where the rubble masonry is carried part way beneath the invert and the invert lining consists of but one ring of brick. In solid rock tunnel there is no lining except one ring of brick on the invert, resting on a thin layer of concrete.

"Two miles of the main trunk is in or through public highways," says *Engineering News*. "The remaining length passes through a deep ravine, whose banks are abruptly vertical to a height of 10 feet at the beginning to 98 feet at the junction with the Genesee river, into which the sewage is, at present to be discharged." Of the construction of the sewer in this ravine the following particulars are given:

"The fall is so great through the ravine, in places 1 foot in 23, that 5 drops, from 6 to 13 feet each have been designed and one shaft 112 feet deep." The drops are constructed with a curve, which is a parabola reversed in a circle to connect with the lower section. The 112-feet shaft is provided with an 8-feet sump, and is shown in section by the sketch below. There is only a temporary outlet to get to the river below the


Surface at Rowe St. – El. 124.3
Sewer, El. abt. 73.0
Hastings Ave.
El. abt. 61.0
El. 48.0
Bank of River
112' Shaft is for temporary Use and a future Overflow when Sewer is extended to a Purification Plant.
112' Shaft
Vertical Bluff at West Bank, Genesee River
8'0" Sump
Overflow
Dry Weather Flow, 20" Iron Pipe, 80' long
Bed of River below Falls El. abt. – 57.0 at Channel.
ENG. NEWS.

lower falls; provision is made to eventually extend the sewer to a point lower down the river and to a purification plant."

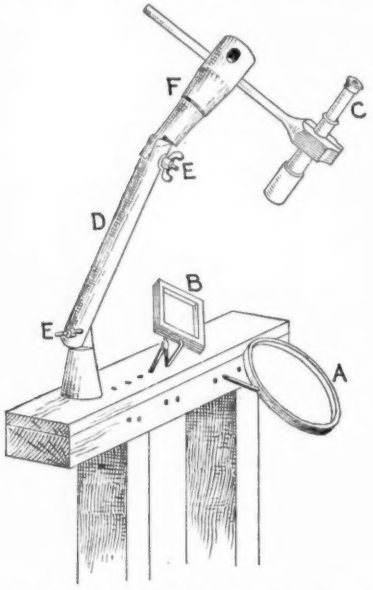
Inspecting Interior of Pipe Sewers.

A SHORT illustrated article in *Engineering News* for September 27, describes a very useful instrument, by which the inte-

rior of a pipe sewer under construction may be quickly and accurately inspected. The publishers have kindly loaned the cut for use in this review.

It is simply a specialized form of the heliotrope. An assistant with a mirror about 8×12 inches in size, throws the sunlight upon the mirror A, which reflects it into the sewer, or upon any desired point. The image thus illuminated is observed through the telescope C, by the reflection in the small mirror B. The two supporting posts shown are no part of the heliotrope.

The apparatus consists of a stick of wood 2×3×20 inches in size, with numerous ¼ inch holes bored through it in both horizontal and inclined positions. Two mirrors mounted on wooden backs, one 6 inches in diameter and the other 2 inches square, are hinged or swung in Y-shaped frames, the branches being No. 6 wire and the stem ½ inch iron rods, 6 inches long.



The wooden timber is laid across the sewer in the manhole, and the rods carrying the mirrors are inserted into the holes conveniently for reflecting the light into the sewer. The observer takes such a position that his back is toward the section of sewer under examination. The image which he thus sees in the mirror B, or in the telescope C, is erect and in its natural position.

The mounting of the telescope is by means of the post D, about 2 feet high, turning on a 1-inch pivot in the bottom. The post is jointed at right-angles at EE, and clamped in position by thumb nuts. It is also pivoted at F. A ½-inch hole is bored through the top of the post, in which turns and slips the ½-inch wooden rod with clamp holding the telescope.

The post can be set up at either end, or at the middle of the 2×2-inch timber, and the telescope, magnifying 10 diameters, can be readily given any position and pointing.

In inspecting sewers in course of construction the heliotrope is set transversely in front of the open pipe, in a similar position to that which which would be taken in the manhole.

The article was contributed by Walter C. Parmley, assistant city engineer of Peoria, Ill. This gentleman asserts that the use of this instrument has had a marked beneficial effect upon sewer construction. Not only were the men more careful in performance of their work when conscious that it would be clearly and fully inspected, but the employment of the device has very materially assisted construction by enabling workmen to obviate faults, the avoidance of which, in the absence of such aid, could only be a matter of surmise. Mr. Parmley, in speaking of the range of power of the device, says it is so ample that he has been able to examine "the inside of a whole block of 4-inch drain tile from one position, and the large sizes are still more easily observed."

The Philadelphia Asphalt Tests.

THE increase of the use of asphalt for the paving of city streets in the United States is notable. With reference to tests of the quality of this material which increasing use renders yearly more important, much information may be gained from a perusal of an article contributed to *Paving and Municipal Engineering* for October by Mr. Dolphus Torrey. Mr. Torrey states that he has worked for months, and has made two or three thousand tests of cohesive strength of asphalt, crude and refined, and also of asphalt cements and pavement mixtures. The reader will find in this article not, perhaps, what he might expect from this assertion —tabulated statements of results of these extensive experiments, but rather some

conclusions from them which the author has been led to adopt provisionally.

A considerable part of the article is devoted to the effect maltha has upon asphalt. Mr. Torrey states "that, for several years, he was firm in the conviction that maltha would be a better material for tempering paving cements than the residual oil customarily used." He now believes that "the determining consideration is that of subsequent chemical stability of the compound," and that "until this determination can be made it will not be prudent to change the current practice." It will be noticed that the author writes of these materials as though chemical combination takes place when they are mixed together, and, indeed, he positively asserts this belief in the paragraph quoted below.

"Contrary to the generally accepted opinion, the author believes the oil does form a chemical union with the asphalt when the mixing is properly done. This being true, it follows that cements made by treatment which does not fully effect such chemical union will be imperfect ones, and tests made with them inconclusive as to the value of the materials. As to the quality of residuum oils used in the construction of any particular pavement, they should be the best obtainable in a commercial way; the distilling being conducted to produce a requisite quality, not an incidental by-product.'

Referring to a previous article contributed to the May number of the magazine quoted, Mr. Torrey recalls what was there said about a process for obtaining by solution four important fractions of an asphalt; and he believes that "the information gained by combining these in various proportions will prove of considerable help for the comparative valuation of asphalt." He concludes this excellent paper as follows:

Assuming that changes of cohesive strength of an asphalt are indications of molecular changes in the material, the author has freed samples from insoluble materials, to obtain what may be called physically pure asphalt. This is combined with various percentages of oil, and the samples so made have been tested at several temperatures, to find what modifications of strength the oil effects. For each point of testing five tests are made, and an average result secured for record. The results admit of graphic representation, and thereby the most ready and comprehensive comparison. In like manner trial has been made of the influence which different percentages of stone dust effect in the way of cohesive strength of cements. These also admit of graphic representation and comparison. It is much too early, in the investigations being made, to venture any announcement of definite conclusions.

Mr. Torrey intimates that these important experiments will be continued and that the final conclusions will be given to the public in practical form. The materials he is thus collecting cannot fail to prove a valuable addition to previous knowledge regarding asphalt.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Gas Supply.

24986. Some Experiences with a Gas Works in a Cold Climate. J. P. Gill (A G L J-Sept. 10.) 1900 w.

*25151. Experience with the Prepayment-Meter System. H. Wimhurst (G W-Sept. 8.) 4000 w.

25175. Experiences with Some Leaky Gasholder Tanks. Ill. J. Chadwick, with Discussion (A G L J-Sept. 17.) 4700 w.

*25203. Retort-House Construction. Ill. W. D. Child, with Discussion (J G L-Sept. 11.) 6400 w.

*25358. Gas from Sawdust (G W-Sept. 15.) 1000 w.

*25431. The Regulations for the Supply of Electricity Compared with Those for the Supply of Gas. Norton H. Humphrys (J G L-Sept. 18.) 3200 w.

*25666. The Production of Gas from Paraffine Oils. (Abstract) J. F. Tocher (J G L-Sept. 25.) 4200 w.

Sewerage.

24960. The Treatment of Sewage by Ferozone and Polarite. Arthur Bowes (E R-Sept. 8.) 1600 w.

25028.—$1.50. Chautauqua, N. Y., Sewage Disposal Works. Ill. William B. Landreth (T C E-July.) 2500 w.

25042. The West Side Trunk Sewer, Rochester, N. Y. Ill. (E N-Sept. 13.) 500 w.

*25134. The Super-Saturation of Sewage Farms. Editorial (Eng L-Sept. 7.) 1100 w.

We supply copies of these articles. See introductory

*25268. The Salford Sewage Works (E-Sept. 14.) 1100 w.

*25273. A Question of Value.—Sewage Treatment. Editorial (Eng L-Sept. 14.) 1500 w.

25291. The Aramingo Canal Sewer, Philadelphia. Ill. (E R-Sept. 22.) 400 w.

†25359. Mr. Silk's Sanitary Tour.—The Sewerage of Berlin (I E-Aug. 25.) 1000 w.

25412. A Device for Inspecting the Interior of Pipe Sewers. Ill. Walter C. Parmley (E N-Sept. 27.) 500 w.

†25524. Sewage Disposal at Worcester, Mass. Harrison P. Eddy (J A C S-Oct.) 1500 w.

25580. The Sewerage and Water Supply Systems of Oberlin, O. (E R-Sept. 29.) 2500 w.

25624.—$1.50. The Sandrock Sewers of St. Paul, Minn. Ill. George L. Wilson (T C E-Aug.) 2500 w.

*25677. The Pollution of the Aire and Calder. Editorial (E-Sept. 28.) 1800 w.

*25684. Electrolytic Sanitation. Editorial (Eng L-Sept. 28.) 2200 w.

Streets and Pavements.

25034.—$1.50. On the Marking of Street Lines. C. M. Broomall, with Discussion (T C E-July.) 3000 w.

*25279. Street Paving in Sheffield (B A-Sept. 7.) 1800 w.

*25515. Specifications for Brick Pavements. J. A. Hall (P-Oct.) 2000 w.

*25517. Maltha as a Flux for Asphaltic Pavement. S. F. Peckham (P-Oct.) 1500 w.

Water Supply.

24959. The Water-Works of Remscheid, Germany. Ill. (E R-Sept. 8.) 1700 w.

25166. The Norwood, O., Water Tower. Ill. (E R-Sept. 15.) 3000 w.

25186. Water Supply Engineering (A S-Sept. 15.) 2300 w.

25187. The American Water Works Association (A S-Sept. 15.) 600 w.

25212. New Pumping Engines for the Chicago Water-Works (E N-Sept. 20.) 1000 w.

25298. The Water Supply of Jersey City. John W. Hill (F. W-Sept. 22.) 3200 w.

25389. Some Practical Points in Water Supply Engineering. R. C. Gemmell (Sc A S-Sept. 29.) 3500 w.

25503. The Lawrence Filter Bed. Ill. (F W-Sept. 29.) 800 w.

25504. Filtration. Ill. Joseph B. Rider (F W-Sept. 29.) 2800 w.

25505. Experiments with Tube Wells at Lowell, Mass. (F W-Sept. 29.) 4300 w.

25534.—75 cts. Electrolysis of Water Pipes. Charles A. Stone and Howard C. Forbes, with Discussion (J N E W-Sept.) 11000 w.

25535.—75 cts. The Filter and the Water Supply of the City of Lawrence and Its Results. Ill. Hiram F. Mill, with Discussion (J N E W-Sept.) 6600 w.

25536.—75 cts. Remarks Concerning a Recent Paper by L. M. Hastings, on the Flow of Water in a Compound Pipe. George A. Ellis, with Discussion (J N E W-Sept.) 3500 w.

25579. The Covered Reservoir at Rockford, Ill. Ill. (E R-Sept. 29) 1500 w.

25622.—$1.50. The Quality of Water Supplies. John W. Hill, with Discussion (T C E-Aug.) 16500 w.

25628. An Expert's Report on the Peoria Stand Pipe Failure (E N-Oct. 4.) 1100 w.

25632. Continuous and Intermittent Sand Filtration of Water. George W. Fuller (E N-Oct. 4.) 3000 w.

25635. Bacteriological Studies of the Toronto Water Supply. E. B. Shuttleworth (E N-Oct. 4.) 2800 w.

25714. The Nashville, Tenn., Water-Works. Ill. (E R-Oct. 6.) 1200 w.

Miscellany.

*24948. The Great Dam at Austin, Texas. Ill. Frank E. Snyder (E Mag-Nov.) 3000 w.

25176. The Prevention of Electrolysis (A G L J-Sept. 17.) 1000 w.

25191. The Element of Beauty in City Parks (G & F-Sept. 19.) 1600 w.

†25259. The Municipal Museums of Paris. Frederic Harrison (F R-Oct.) 4500 w.

25299. Progress of Electricity in Municipalities. Charles A. Rolfe (F W-Sept. 22.) 3000 w.

25413. The City Ownership of Street Railways (E N-Sept. 27.) 1300 w.

*25476. Betterment (A L-Sept. 21.) 3400 w.

*25516. Cincinnati's Municipal Purchasing Agency. Aug. Herrmann (P-Oct.) 900 w.

*25518. Municipal Ownership of Subways. C. H. Morse (P-Oct.) 800 w.

Serials.

18870. Humidity and Ventilation. The Effective Ventilation of large Public Buildings. Joseph Nasmith (A Ar-Began June 13, 1893—Ended Sept. 22, 1894—5 parts—15 cts. each).

21592. The Harlem River Speedway. Ill. (E R-Began April 28—9 parts to date—15 cts. each).

23641. Details of Rural Water Supply (B-Began July 7—13 parts to date—30 cts. each).

24751. The Gas Manager Abroad. F. W. Cross (G W-Began Aug. 25—5 parts to date—30 cts. each).

25117. Remarks on the Gas Industry in America. H. Bunte (P A-Began Sept. 15—2 parts to date—15 cts. each).

25179. The Water Service and Fire Protection of Theatres. William Paul Gerhard (F W-Began Sept. 15—4 parts to date—15 cts. each).

25202. Illuminating Power and Illuminating Effect. J. T. Sheard (J G L-Began Sept. 11—2 parts to date—30 cts. each).

25347. About Water Gas. Edwin A. Down (G E M-Began Sept 10—1 part to date—30 cts).

RAILROADING

A New Wool Test for Color Blindness.

A NEW test for color blindness, of the kind known as the "*wool* test," is practically discussed in an article printed in the *Railroad Gazette*. It is written by William Thomson, M. D., well known in connection with such tests. This new test is stated to be an improvement upon the "color-stick" and arrangements of wools adopted by the Pennsylvania Railroad Company in 1880, and has been devised after much study of the subject by the author of the paper under review.

The color-skeins of this new arrangement have been carefully selected, and a standard set will be kept, so that renewals may be made of the entire set of those skeins that may become faded, soiled or lost. The new set consists of a large green and a large rose test-skein, and forty small skeins, each marked with a bangle having a concealed number extending from 1 to 40, placed in a double box, so arranged as to keep the two series apart and to permit each to be exposed upon a table in a confused mass.

Those who desire to acquaint themselves with current methods of testing for color-blindness, and the extent to which they are used on railways, in the selection of signalmen, cannot afford to neglect the perusal of this excellent article. It is very difficult to quote from it any part which will give a good idea of the whole, on account of the intimate connection each has with the whole subject. What the author has to say about the use of the new test in examinations follows:

The large green skein being placed near by, the small skeins from 1 to 20 are exposed in good daylight, and the employé under examination is directed to select ten shades of the same color of the text-skein. One with normal vision will choose promptly and with ease the ten greens with odd numbers on the bangles. A color-blind person will hesitate, and his selections will contain some even numbers, and the confusion-colors will be shades of brown, etc., containing some red or shades of gray, and will indicate the color-defect. These figures are to be recorded on a blank, and the twenty skeins are to be removed. The large rose skein is then used and the examination repeated in like manner with skeins numbered from 21 to 40, and the result recorded. The confusion-skeins which have even numbers are blue, green and gray. From the selections made by the man found color-defective by the green-test, we are able to decide the character of his color-blindness. Those selecting blue are red-blind; those taking greens and grays are green-blind, according to the nomenclature of Holmgren. There are ten roses and ten confusion-colors in the second series.

The red test-skein of the stick, with its confusion-colors, is omitted entirely, and the test is made to conform more strictly with Holmgren's method, while the examiner is also provided with 40 questions of decisive clearness. Greater scientific accuracy is obtained by this method, and with the careful selection of these confusion-colors I now regard this system as an improvement upon the stick, and as a safer and more simple method to be used by a non-professional examiner.

Light Railways in England and France.

IT seems that the experiment of very light, narrow gage railways is again to be tried. Between 1860 and 1870, it will be recollected, narrow gages were strenuously advocated, and as urgently opposed, and, as it then appeared, upon such good grounds, that the narrow gage roads of the time only survived to be used temporarily in a small way, in carrying earth and broken rock from excavations and transportation of materials through short distances from points of delivery to parts of constructive work where needed. At least the reviewer does not now recall any instance of its survival for passenger or freight traffic, except in some mountainous regions where the exigencies of the case has compelled their use. The controversy at the time was generally spoken of by engineering publications as the "battle of the gages." There were, however, those

who advocated even wider gages than the general standard now in use. A notable example was the New York and Erie Railway, which having adopted a wide gage subsequently abandoned it for the standard gage. Now the *Railway Times* tells us that an interesting exhibition has just been held at Duffield Bank, near Derby, England.

The primary object of the exhibition was to solve the various problems involved in the successful designing of engines, carriages, and roadway of the narrow gage. The chief ends in view were, first, the application of narrow gage lines to agricultural and commercial purposes, and, secondly, to the requirements of military transport in countries destitute of roads. The latter point some years ago engaged the attention of the Royal Engineers. The construction of this line of 15-inch gage was begun in 1874, and various additions were made up to 1881, when the length laid amounted to about a mile, inclusive of sidings. Since the latter date there has been no material extension, but the permanent way and its accessories have been improved. The line runs from the farm and workshops up a gradient, varying from 1 in 10 to 1 in 12, about a quarter of a mile long, to a level 80 feet above, where the experimental course is laid out in the shape of a figure 8, so as to admit of continuous runs. This part, somewhat more than half a mile in length, has a level stretch of a quarter of a mile, the remainder consisting of gradients of which 1 in 25 is the most severe. The maximum curve on the main line is of 25 feet radius, but in the sidings some occur which are as sharp as 15 feet radius.

It therefore appears that the narrow gage is up again for reconsideration, and this is further apparent from the fact that for two years a line of 2 feet gage has been in operation in the department of Loiret, France. Very full particulars of the permanent way, etc., in the Derbyshire experiment are given. The gage of this miniature railway, as has been said, is only 15 inches, and its length is about one mile. The account of the entire outfit is given, and is full of interesting particulars. It is said that the Royal Engineers have been inspecting the locomotives used, with a view to adopting the plan on the military railway at Chatham.

The length of the French line spoken of is 22 kilometers. It is used for both freight and passengers, and is laid right along the side of the public highway, so that farmers (this a beet-root district) can lay temporary sidings, and run their loaded cars out to the main track. Herein a proper and advantageous function of the narrow gage railway seems to have been discovered; and if such a road has any prospect of being profitable, as is hoped, in France where the roadways are probably as good as can be found anywhere in the world, there would seem to be many places in the United States (in which the highways are notoriously bad) where the system might be profitably introduced.

The Cowlairs Incline.

POSITIVELY one of the most interesting articles of a descriptive character relating to railroads that has reached the reviewer's table, during the current month, is that indexed under the title, "The Cowlairs Incline on the North British Railway."

This article, written by M. A. Lockyer, and magnificently illustrated from photographs taken by Mr. Lockyer himself, is printed in *The Railway World* (London) for October. Nothing finer in the way of illustration than the pictures of special features of this famous railway incline have ever appeared in any publication devoted to railroading; and the description will be read with interest by railroad men even though they chance to be familiar with the peculiarities described.

The illustrations are a view of the exterior of the engine-house at the top of Cowlairs Incline; the main driving pulley, in two sections, ready for putting in place; interior of the engine-house; "messenger" affixed to locomotive at foot of the incline; men splicing the cable (which is entirely a different matter from, and must not be confounded with, what sailors call "splicing the mainbrace"); brakesman removing "messenger" from rope; train descending incline to Queen street, Glasgow, in charge of brakemen; train and brake vans at top of Cowlairs Incline, and West Highland train ascending incline to Cowlairs station.

These illustrations are all immediately pertinent to the descriptive text, and hence their mere enumeration will convey a good idea of the article when it is added that the description is not made to fit a set of illustrations as is frequently the case in this kind of article, but the illustrations are entirely subordinated to the demands of the subject. The introductory paragraph introduces the reader at once to an interesting fact, as follows:

It scarcely seems credible that, notwithstanding the enormous increase of traffic and the use of heavier rolling stock generally, machinery put down in the beginning of the year 1842 and continually working, should still be in good repair and full working order; and yet such is the case with the haulage plant at Cowlairs, which both on account of its age and history deserves attention. The incline, which lies between Cowlairs and Queen Street terminal station, Glasgow, commences at the entrance to the tunnel and terminates at Cowlairs station, where the haulage engine and consequently the main part of the gearing are situated. It is a mile and a half in length, having a gradient of 1 in 42, the lower half being under tunnel.

The order of treatment then proceeds with a description of the engine-house (architecturally noteworthy) with its engines and appliances; the incline and rope (or cable as we should call it in the United States) and, lastly the method of working. As the article fills something over 5 large quarto pages, only one or two of the interesting details described in it can be brought under review, as fair samples of its general interest and value.

A bit of characteristic description is quoted in the following paragraph:

"In 1844 the engine was stopped altogether, the company thinking that perhaps locomotives would serve the purpose better. Four powerful engines were accordingly built; two (Samson and Hercules), at Cowlairs Works, and the remainder (Millar and Hawthorne), at Newcastle, causing at the time considerable excitement. But this expedient proved a failure, although by this it is not necessarily meant that the engines could not do the work, which was, however, sometimes the case; but the exhaust steam kept injuring the tunnel, while the engines when wanted at Queen street were often at Cowlairs, and vice versa. The stationary engine was accordingly once more put into working order, and it was at this period that the cylinders were increased in diameter, and the haulage-rope, instead of being made of hemp as formerly, was constructed of iron-wire, the rope being supplied to the company by a Newcastle firm, R. S. Newall & Company, famed for their untwisted wire-rope. The engine was finished by the 4th of March, 1847, and on trial under the new conditions of haulage proved highly satisfactory; so much so that the four locomotives were removed altogether, and the locomotive superintendent at that time, Mr. Paton, and others concerned, gave up the idea completely, nor has it again been tried."

As in the paragraph quoted so in other parts of the article practical information is so happily combined with description, as to fully justify hearty commendation.

Many American readers will wish to know what is the technical meaning of the word "messenger" several times alluded to in the subjects of the pictures above named. Even this bit of information, which a careless writer would have probably overlooked is given. The author defines it as "a name given to the chain which connects the train engine to the rope, the unsatisfactory working of which was one of the reasons for trying the experiment of substituting locomotives for cable traction above narrated. In wet weather it slipped on the hauling rope; but after the substitution of wire rope for the hemp rope previously used was made, the author says that it operated satisfactorily.

Notes on German Railroad Practice.

UNDER this title Mr. E. M. Herr contributes the last of an instructive and entertaining series of articles to *The Railroad Gazette*, dealing with the construction, maintenance of way, general statistics and statistics of traffic of German railroads, with other interesting particulars concerning them. He concludes the article with an allusion to "the careful, systematic, and thorough study which German railroad engineers and managers have made in recent years of the business of railroading in all countries, but more especially in the United States." He says: "One sees everywhere

substantial evidence of the completeness of their investigations into American practice, and of the care and skill with which they are adapting to their use the American methods and devices best suited to the needs of their service."

He calls attention to the fact that German railroads were not built, like most American roads, for the purpose of developing a new country; they were, on the contrary, intended "to accommodate an already dense population." They were accordingly much better constructed than were most American roads at the start. At the expense of heavy and expensive construction work, "serious grades and sharp curves were avoided." Such expensive construction has been deferred in the United States until increase of traffic promised earnings that would warrant investments of additional capital. The author states that in the German railroads "the subway, comprising all embankments, cuts, bridges, culverts, foundations, retaining walls, etc., is well constructed and cared for. Ballast is spoken of as "very ample on the principal lines, and rather deficient on important branches." Of wood ties the author says their increasing price is leading to a more extensive use of steel ties. In 1892, nearly 20 per cent. of all ties used on these roads were metal. Wood ties are almost universally treated with zinc chloride as a preservative. "The average cost of wood ties during the year 1892, on all German lines, was $1.14 each, while the cost of metal ties weighing 109 pounds each during the same year was $1.70." Rails of T-section are mostly used, averaging a little over 67 pounds per yard.

The average cost of maintenance and repairs to track, roadbed, stations, yards, signals, telegraph, and all other parts of the permanent way, and buildings, including bridges, tunnels, workmen's houses, coal sheds and chutes, was during the year 1892, per mile of line, $1.575; ditto per mile of track, $916; ditto per 1000 locomotive miles, $122.17; ditto per 100 car-axle miles (all kinds), $4.84.

Those who are urging state ownership of railways in the United States will find an argument in support of their views in the fact stated by the author, that 90 per cent. of all German railroads is absolutely owned and run by the German government. Mr. Herr says "the management is careful, conservative, and in general serves well the needs and requirements of the people."

German passenger traffic is divided into four classes besides the military, each of which has a special tariff, is handled in different cars, or at least in different parts of the same car, and is accounted for separately from the others.

This practice differing from that of any American line, the author gives in this connection, as of interest for comparison, a tabulated analysis of the German passenger traffic for the year 1891-92, for which those who desire details must consult the article itself. Tables of other interesting statistics, including classification and lengths of German roads in miles, comparison of equipment and traffic of the United States with the German, a similar comparison of average general and operating expenses, etc., are supplied, thus rounding up and completing an excellent series of articles.

Railways of the United States.

THE *Safety Valve* gives a comprehensive summary of facts relating to the railways of the United States compiled from the sixth annual report of the Interstate Commerce Commission. The statistics given in this summary are in convenient form for reference, and will be useful for this purpose to railway men, and also to the general reader, in connection with the current debate on the relations of the state and general governments to railways and railway corporations as a factor in the industrial disturbances which have recently agitated the country. The summary, even in its condensed form, being too long for transcription here, only general features can be indicated. It gives the number of employés in service on June 30, 1893, and the distribution of this service in various departments; the aggregate value of railway property, and the value represented in different investments and securities, together with the total indebtedness and the classified indebtedness; the total amount

of stock paying no dividends, and of different securities paying no interest; total business of the roads, with totals of classified traffic, passengers, etc.; gross earnings; operating expenses; net income available for dividends; number of railway employés killed during the year ending June 30, 1893; number of passengers killed, etc.

One of the most striking things in the report is the railroad stock which pays no dividends. A movement toward securing uniformity in railway accounting, and the neeessity of a more complete compilation of freight statistics are mentioned; and *The Safety Valve* says "it is probable that something akin to a clearing house of freight statistics will become a necessity in the near future."

Light Railways.

IN another place in this Department something has been said upon the revival of interest in light railways as feeders of traffic for main lines. The interest in the subject now manifested in English railway circles seems to be decidedly increasing. *Transport* (Sept. 28) prints an unsigned leading article upon the subject broadly reviewing the opinions expressed by several prominent railway men at a recent meeting of the great North Scotland Railway Company.

The article states that the present revival of interest in the subject has been initiated by the necessity for something to help farmers in these days of depression and keen competition, by providing them with facilities for getting their produce cheaply to market. The matter has been discussed in a desultory fashion at the half-yearly meetings of a number of other English railway companies, and it has engaged the attention of newspaper writers, engineers and railway experts.

The principal obstacle to progress in experimental light railway lines for agricultural districts in the United Kingdom are the rules of the board of trade. This point was made prominent in the speech of Mr. Ferguson, at the meeting of the Scotland Railway Company above named. Upon this part of Mr. Ferguson's remarks the article reviewed makes the following comment.

> The most significant part of Mr. Ferguson's speech, however, was his reference to the requirements of the board of trade, which. as has been frequently pointed out by *Transport*, have proved an insuperable barrier to an extension of railway enterprise in this direction. It does certainly seem ridiculous that in an outlandish part of Aberdeenshire, where a railway is urgently needed to convey the produce of a scattered agricultural population to the nearest remunerative market, the line should be equal, in all its essential features, to the London and North-Western system between the metropolis and Carlisle. It is certainly to be hoped that parliament will next season, pass such a measure as will provide for a substantial relaxation of the board of trade regulations in regard to signalling stations and other matters, and thus simplify the efforts of those who are promoting industrial development by this means.

Many practical points relating to the construction and operation of this kind of railway, as exemplified in Wurtemburg, Saxony, and in France, where they have been in operation long enough to afford precedents, are stated in this well written and well considered article. Speaking of the light railway between Pithiviers and Toury in France, intended to accommodate the beet-root industry of the region, the author says:

> Important branches have been laid down by cultivators and manufacturers, and it is pointed out that an important feature in connection with this type of line is the facility with which branches can be laid and worked, as the gathering of the crops may require. The line is not materially different from many others which have been built on the continent, but it is an object lesson to those who look with disfavor upon the laying of such railways in this country. At all events I commend it to the attention of the Aberdeenshire people, who have begun to see the benefits which light railways would give to that important agricultural county.

The breadth of view and the evident familiarity with all aspects of the subject which characterize the article will commend it to progressive railroad men. There is undoubtedly a field for this kind of railways now opening, and the future looks promising.

A LOCOMOTIVE Tire Wear Indicator is described in the *Railway Gazette* (Sept. 14) with illustrations of its construction, and detail of the manner of using the instrument. The results of its use have, in the opinion of the paper quoted, settled conclusively some questions as to causes and peculiarities of tire wear, that were long a puzzle to railway men. Among these peculiarities is the fact that on locomotives running alternately backward and forward the wear is more uniform than on those which nearly always run in one direction. The angular position of the wear, as referred to that of the crank-pin, also presents marked peculiarities on locomotives used for different kinds of service. The article, though a short one, contains valuable information upon an important subject. For example, a locomotive used in heavy fast passenger service on a hilly division showed a slight amount of wear on the tire of the left front driver, just forward of a point in line with the crank-pin of the right-hand driver or about seventy degrees back of the left crank-pin. A locomotive of the same class used in local passenger service, showed at the same point a much greater wear, and at corresponding points on the other drivers, a somewhat less but perceptible irregularity. A four-wheeled switching locomotive showed a maximum wear on all drivers at a point about thirty degrees back of the position of the right-hand crank-pins, the wear extending, however, in each direction for nearly the whole circumference of the drivers.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*24306. La Guaira and Caracas Railway. E. H. A. Heinke (R P L-Aug.) 1500 w.

24975. A Survey of the Railway Situation. Extract from Address of M. E. Ingalls. (R R-Sept. 8.) 2000 w.

24977. The Transportation Exhibit at the World's Columbian Exposition. James Dredge, with Editorial (R R-Sept. 8.) 2200 w.

24978. Freight Locomotives in Germany and England (R R-Sept. 8.) 1000 w.

*25019. The South Eastern Railway. Ill. (R W-Sept.) 2400 w.

25033.—$1.50. Brofford's Ridge Tunnel. Ill. Charles W. Staniford, with Discussion (T C E-July.) 3000 w.

25046. Changing the Gage of a Southern Mineral Railway. Hunter McDonald (E N-Sept. 13.) 1100 w.

25048. Cuban Railroads (R G-Sept. 14.) 2000 w.

25049. A Locomotive Tire Wear Indicator. Ill. (R G-Sept. 14.) 600 w.

25050. A New Wool Test for Color Blindness. William Thomson (R G-Sept. 14.) 1400 w.

25072. Types of Side Framing for Passenger Cars. Ill. (R C J-Sept.) 3000 w.

25073. Early Railroad Cars. Ill. (R C J-Sept.) 3500 w.

*25126. Railway Development in the South Yorkshire Coalfield (E-Sept. 7.) 1500 w.

*25132. Great Northern Railway.—Reconstruction of a Bridge over the Don. Ill. (Eng L-Sept. 7.) 600 w.

*25138. Manitou and Pike's Peak Railway. Ill. Thomas F. Richardson (J A E S-Aug.) 6200 w.

*25152. New Zealand Railway Policy (Tr-Sept. 7.) 3000 w.

*25154. A British Railway Question in Asia Minor (Tr-Sept. 7.) 1300 w.

25182. Standard Track Tools (R R-Sept. 15.) 600 w.

25184. What Are the Best Means of Saving Coal and Increasing or Holding the Mileage per Ton to a Desirable Figure? (R R-Sept. 15.) 1200 w

25185. Judicious Interlocking. Editorial (R R-Sept. 15.) 1200 w.

25190. What Is the Proper Basis for Freight Rates? Statements of J. W. Midgeley and M. C. Markham (R A-Sept. 14.) 1600 w.

25215. The Hall Signal System of the D. L. and W. R. R. and D. and H. R. R. Ill. (E N-Sept. 20.) 900 w.

25218. An Ancient Locomotive. Ill. W. F. Durfee (Sc A-Sept. 22.) 700 w.

25244. Compressed Air in a Railroad Shop. Ill. W. B. Ruggles (M A-Sept.) 800 w.

25250. Notes on German Railroad Practice. Construction, Maintenance of Way, General and Traffic Statistics. E. M. Herr (R G-Sept. 21.) 1000 w.

25252. The Proposed Standard Specifications for Locomotive Boiler Steel. Editorial (R G-Sept. 21.) 3000 w.

We supply copies of these articles. See introductory.

*25255. Railroad Travel in England and America. Ill. H. G. Prout (Sc M-Oct.) 20000 w.

*25260. Light Railways in England and France (Ry T-Sept. 15.) 1600 w.

*25262. Railways in China (Ry T-Sept. 15.) 1200 w.

25296. The Seniority Rule.—Its Disadvantages to the Trainmen and the Railways. C. H. Dascombe (R A-Sept. 21.) 1000 w.

*25307. The New South Wales Railways (Tr-Sept. 14.) 2500 w.

*25324. The Railways of Australia (B T J-Sept.) 2200 w.

*25369. The Electric Locomotive of To-Day.—An Interview with M. Bunau-Varilla. Ill. (M-Sept. 15.) 1200 w.

25375. The Basis of Transportation Rates. (R R-Sept. 22.) 2100 w.

25382. Train Motion and Resistance. R. E. Horton (A M-Sept. 27.) 1600 w.

*25400. Can Railroad Rates Be Cheapened? Harry T. Newcomb (F-Oct.) 3000 w.

25404. Artillery in the Locomotive Repair Shops. Ill. (R G-Sept. 28.) 400 w.

25406. Some Economic Features of Locomotive Evolution. Editorial (R G-Sept. 28.) 2200 w.

25407. Ventilation for Passenger Cars. Editorial (R G-Sept. 28.) 1500 w.

25408. The Evolution of the Railroad Club. Editorial (R G-Sept. 28.) 1200 w.

*25456. Notes on Steel Sleepers. W. H. Cole (I & I-Sept. 21.) 1200 w.

*25468. The Argentine Railways (Tr-Sept. 21.) 500 w.

*25489. Development of Railroads in the United States. Ill. Brandt Mansfield (Ch-Oct.) 3000 w.

25510. Car Doors and Fastenings. J. J. Frey (R R-Sept 29.) 1200 w.

†25547. Rebuilding the Pennsylvania Railroad after the June Flood of 1889. Joseph T. Richards, with Discussion (P E C P-April-June.) 6600 w.

25562. The Lubrication of Locomotives (Eng-Sept. 29.) 2000 w.

25588. Government Ownership of Railways. Where It Is Being Tried (R A-Sept. 28.) 800 w.

*25596. Interchange of Cars in Europe. A. S. (L E-Oct.) 1000 w.

25623—$1.50. Tequixquiac Tunnel, Valley of Mexico. Ill. Albert Johnstone Campbell and Frederick William Abbot (T C E-Aug.) 9000 w.

25630. How Can Present Methods of Rating Train Loads Be Improved. W. W. Wheatley (E N-Oct. 4.) 3000 w.

25637. C. P. Huntington's Views.—An Exhaustive Opinion on the Benefit of Railway Combinations (M R-Oct. 5.) 900 w.

25645. The Safest Place in a Railroad Train. H. G. Prout (A An-Oct.) 1500 w.

25646. The Production and Consumption of Steel Rails. J. Stephen Jeans (R G-Oct. 5.) 1700 w.

25647. New Passenger Station at Syracuse. Ill. (R G-Oct. 5.) 400 w.

25649. The New York Central Report (R G-Oct. 5.) 1800 w.

*25678. Self-Contained Electrical Locomotives (Heilmann's System). C. S. Du Riche Preller (E-Sept. 28.) 800 w.

*25681. Colonial Locomotives (Eng L-Sept. 28.) 4200 w.

*25746. The Light Railways Question (Tr-Sept. 28.) 1800 w.

*25750. The Relation of Railroad Transportation to Production in California. R. L. Dunn (I S F-Oct.) 5600 w.

*25825. The Cowlairs Incline on the North British Railway. Ill. A. E. Lockyer (R W-Oct.) 2000 w.

Serials.

15496. Railroad Copper-Smithing. Ill. John Fuller, Sr. (L E-Began Sept. 1893—11 parts to date—30 cts. each).

17826. Evolution of the Air-Brake. Ill. Paul Synnestvedt (R E M-Began Dec.—10 parts to date—15 cts. each).

23719. The Early Railway Routes to Scotland. G. A. Sekon (R P-Began July—3 parts to date—30 cts. each).

23887. The West Highland Railway. Ill. (E-Began July 20—Ended Sept. 28—6 parts—30 cts. each).

24477. A Historical Sketch of Railroad Signals. Ill. Arthur H. Johnson (R G-Began Aug. 17—Ended Oct. 5—3 parts—15 cts. each).

24621. Rules and Instructions for the Guidance of Railway Agents (R R-Began Aug. 25—5 parts to date—15 cts. each).

24660. The Compounding of Locomotives. A. H. Tyler (E Rev-Began Aug.—Ended Sept.—2 parts—30 cts. each).

24741. The Relative Efficiency of Air Compressors and Locomotive Air Brake Pumps for Shop Use (R E M-Began Sept.—2 parts to date—15 cts. each).

24809. Car Shop Economy. James F. Hobart (I C B-Began Sept.—2 parts to date—30 cts. each).

24817. Recent Turn-table Practice. Ill. R.) R-Began Sept. 1—4 parts to date—15 cts. each).

24896. The Conversion of Metre Gauge to Indian Standard (5′ 6″) Gauge on the Bengal-Nagpur Railway. Ill. G. Moyle (I E-Began Aug. 14—4 parts to date—45 cts. each).

24938. Passenger Train Service in 1894 (Tr-Began Aug. 31—3 parts to date—30 cts. each).

25663. The Mushkaf-Bolan State Railway (I E-Began Sept. 1—1 part to date—45 cts).

25670. Special Shop Tools. Ill. (R E M-Began Oct.—1 part to date—15 cts).

25674. The New Central Railway Station at Lisbon. Ill. (E-Began Sept. 28—1 part to date—30 cts).

STREET RAILWAYS

Street Car Fenders.

"SOME time ago," says the *Railroad Gazette*, "a commission was formed in Baltimore, Md., consisting of the Mayor, City Register, and City Commissioner, for the purpose of considering the subject of life guards for trolley cars. The paper quoted (issue of Sept. 21) gives in an article of something over two columns the substance of the report made by the expert employed by this commission. The commission obtained the assistance of Mr. Cohen, Past President of the American Society of Civil Engineers; and as the investigation included critical examination of seventy different types of fenders, his report contains valuable information to all interested either in trolley or cable railways. The report of Mr. Cohen, begins with the ordinary cow catcher; and the fact that in tracing up the various inventions in this line, he found as many as seventy different ones shows well the importance that has attached to the subject. It is not proposed in this brief review to deal with each of the fenders named in the report. The general principles laid down, and the requirements for a good street-car fender, as stated by Mr. Cohen, are, however, worthy of more than a passing notice. If all inventors of this class of devices had possessed as clear a comprehension of these requirements as Mr. Cohen displays, there would have been much less wasted effort in attempts to supply what is essential. Mr. Cohen says, "what is needed is a very simple piece of work, the more simple the better."

It is required that the front surface of the car, striking a human being, shall be so arranged as to afford a reasonable prospect of saving the person from being dashed to the ground; and further so arranged, that it shall do the least possible damage by its own impact; and further, if it fails to do the duty expected of it, and the person does fall to the ground, or is already lying there, that it shall be devised so as to pass over him without causing further injury; and that there shall also be on each car a suitably arranged guard, preferably of angular or "pilot" form, which shall be automatically brought in close contact with the street and rails, in order to prevent the crushing of the victim, whom the front device has failed to save.

Mr. Cohen found only two fenders that he recommended to the commission. But he says "neither of these came fully up to the requirements, though each contain good and valuable features." If this report be accepted as conclusive, the ideal street car fender has not yet been produced. Mr. Cohen decisively condemns all fenders the object of which is to scoop up persons either standing or falling, "but which make no provision for the contingency of failure to pick up the victims." He regards with favor only such as failing to pick up the victim will not by their form cause injury by passing over him. Of the latter five were found which are thought capable of doing good and effective service. All of these comprise both a fender and wheel guards. Some of the fenders in use are said to have fatal objections. One of these used in Boston is stated to have been recently condemned in that city, and the same fender used on several street railway lines in Brooklyn has struck and killed several children. The report, coming from so prominent an engineer as Mr. Cohen, will, doubtless, do much toward correcting erroneous opinions as to the efficacy of fenders offered to street railway companies by sanguine inventors.

Comparative Efficiency of Electric and Cable Tramways.

MR. FRANK B. LEA, in discussing this question in the London *Electrical Engineer* (September 14), maintains that in respect to economy and efficiency of working there is not much choice between the cable and

the electric system, and that each method should be used in its proper field, having reference to the conditions under which the line has to be worked. From tests published not long since in the *Railroad Gazette*, he finds that the constant loss from the friction of the cable and machinery in four different plants ran from 16.48 per cent. to 20.82 per cent. Without citing any authority, he states that the average efficiency of an electric system may be fairly taken at 78 per cent., or a loss of 22 per cent. of the power at the dynamo-terminals. This would seem to be a very superficial view of the subject. The only adequate criterion is the cost per car-mile, worked out for at least a full year, between such a cable plant as that on Broadway, New York, and an electrically operated line of equivalent capacity, or nearly enough so to render the comparison a fair one, such for instance as some one of the lines now in operation in Brooklyn and Philadelphia. In the case of a light or irregular traffic, there is not much doubt as to the superior economy of the electric system, but whether the cable system on Broadway, for instance, could be replaced by an electric system which would do the same work more economically, is a problem which has as yet by no means received a final and conclusive solution.

Economy in Electric Power Stations.

OWING no doubt in some measure to the financial stringency of the past two or three years, an unusual amount of attention has been given by thoughtful station-managers to the question of economy in the production of electrical energy. It is difficult to say anything actually new on this well-worn subject, but it is nevertheless a matter which will bear a great amount of discussion without disadvantage to anybody. Mr. J. B. Craven, in a paper read before the New York Street Railway Association, and printed in the *Street Railway Gazette* (September 22), dwells particularly upon the importance of looking after the boilers. "No greater mistake"—he says—"is made than to place the care of boilers in incompetent hands, for they require the highest degree of care, conscientiousness and constant attention." The fireman is the man who shovels dollars under the boiler, and a thoroughly good man may save many times the amount of his apparently high wages. Mr. Craven advocates the use of direct connected plants, and insists throughout upon the absolute necessity of employing competent men, and paying them what they are worth. After all, this is the alpha and omega of economy, in electric power-stations or anywhere else. Nothing is more expensive than ignorance, and in no known place has ignorance proved to be more expensive than in or about an electric-light or power-plant.

Street Regulations.

A TIMELY article upon a subject that demands immediate attention has been contributed by Mr. Albert Weimer to the Philadelphia *Public Ledger*, and reprinted in the *Street Railway Gazette*. Mr. Weimer calls attention to the necessity of legislation to define the duties of the various classes of persons who use the streets, under the changed conditions imposed by the "simultaneous introduction of electric cars and bicycles." He suggests that the rule that persons and vehicles should keep to the right, should now be made imperative. "If it were well understood by everybody that this rule will be enforced under penalty," both pedestrians and drivers could rely upon certainty in the action of others, and accidents would be avoided."

The rule of some companies requiring cars to come to a full stop on the near side of streets to be crossed is spoken of as materially lessening the efficiency of roads where this rule has been adopted; and it is "so irregularly carried out that it leads to great uncertainty and confusion in the minds of pedestrians and drivers, and many resulting accidents."

"A complete circuit was made on the Tenth and Eleventh street line (Philadelphia), and it was found that the car made 35 full stops on the near side of the street crossed, while it crossed 152 streets without making any stop at all. On the Twelfth and Sixteenth street line two full circuits were made. On the first the car made 88 full stops on the near side of the streets, and

passed 112 streets without stopping at all. On the second circuit the car made 93 full stops, and passed 107 streets without stopping. In these observations only streets were noticed which were of a width to allow at least two wagons to pass each other. It will be seen by the above figures that there must be a great uncertainty in the public mind as to what are the streets at which stops are made, and what streets are passed without stopping at all. This confusion is further increased by the fact that some of the companies do not require any stop at all, except when passengers are taken up or let off. Another serious objection to the 'near side' rule is that during the winter, when the streets are obstructed with snow and ice, passengers will have great difficulty in getting on or alighting from the cars.

"It seems to the present writer that, if the limit of speed of electric cars was somewhat reduced, and all cars are required to slow down when approaching streets which are much traveled or upon which street railways are operated, our new system of railways would be much more efficient in securing us rapid transit, and that many elements of danger would be eliminated."

The remainder of the articles comprises a proposed new code of street regulations, which have evidently been very carefully thought out, and which, if not all approved, cannot fail to prove suggestive upon an increasingly important subject.

Graphic Records of Street-Railway Statistics.

IN the operation of electric power-plants, and more particularly in the case of street-railway plants in which the readings of consumption meters are unavailable as a check on the output of the power-station, it is too often the case that the profits of the enterprise escape through numerous unsuspected leakages, not individually large, but large enough in the aggregate to make all the difference between financial success and financial failure. The modern electric plant is so well systematized that it is not at all difficult to collect the necessary data bearing upon the different items of cost of operation, yet if, as is often the case, the significance of these data is permitted to lie buried in the records, very little is gained by the mere fact of their existence. In the *Street Railway Journal* (October) Russell Robb gives instructive examples of graphical charts, compiled from the results of the actual operation of a street-railroad, and explains their interpretation. The diagram sheet for the weekly record is ruled vertically for days, with a heavier line marking the divisions of the week, while the horizontal lines are provided with a set of marginal scales indicating "passengers carried," "car-miles run," "kilowatt hours," output of station and "pounds of coal" consumed. These scales are so proportioned to each other as to bring the curves conveniently near each other upon the diagram for comparison. Of course, there is nothing new in all this, but the full significance of such curves is not always appreciated as it should be. For example, if the coal line approaches more and more the kilowatt-hour line, it is evident that the efficiency of the plant for some reason is falling off. The character of the curve may indicate the nature of the trouble; as for example, an abrupt change in its direction coincident with the substitution of a different kind of coal, would indicate that the difference was due to the quality of the fuel. So also, the approach of the kilowatt-hour curve to the car-mile curve would indicate some change in the conditions outside the station. If this were due to an increase in traffic, the evidence of the fact would be found in the relative positions of the car-mile and passenger curves. A decrease in the efficiency of the car-motors, or an increase in the losses on the line would be shown by a gradual approach of the curves. With such a chart in the superintendent's office, kept carefully up to date, it would scarcely be possible for serious depreciation to go on without calling attention by striking and immediate evidence to the true state of affairs.

THE magnificent mammoth souvenir of *The Street Railway Journal* celebrating its tenth anniversary contains 122 large quarto pages of reading matter plus 92 pages of advertising exclusive of cover. A large part of this space is occupied with matter pertaining to the annual convention of the American Street Railway Association, ac-

companied by portraits and brief personal sketches of the men who are most prominent in the organization. Other articles describing the city of Atlanta and other southern cities, with a catalogue of the exhibits, a list of applicants for space and the amount of space awarded to each, the leading articles all handsomely illustrated (there are over 400 of these illustrations), make this one of the most remarkable numbers ever issued in the history of trade journalism.

A history of street railways is another feature of this souvenir number that ought not to be missed in these reviews, but justice cannot be done to it in the space here afforded. In an elegantly illustrated article of 14,000 words the writer has presented a more comprehensive epitome of the origin and progress of the great street railway industry than has been put in print in any serial publication. The first street railway car ever built is illustrated, and from this to the modern street car and the electro-motor of to-day a great many rapid steps are reviewed.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

24989. Multiple Fuse Arresters. Ill. C. S. Van Nuis (S R G-Sept. 8.) 1300 w.

*25018. Tramway Rails Welded by Electricity. Ill. (R W-Sept.) 1400 w.

*25020. Isle of Man Electric Tramways. Ill. (R W-Sept.) 2000 w.

*25021. London United Tramways, Limited. Ill. (R W-Sept.) 1800 w.

†25060. The Electric Brake in Practice. Ill. Elmer A. Sperry (T A I E E-Aug. and Sept.) 6500 w.

*25097. Mechanical Traction for Tramways. Editorial (P Eng-Sept. 7.) 1500 w.

25169. The Series Method as a Remedy for Electrolysis. Nelson W. Perry (S R G-Sept. 15.) 2400 w.

25217. Recent Improvements in Cable Traction. G. W. McNulty (E N-Sept. 20.) 5000 w.

25249. Combined Curb and Conduit System. Ill. Gustave Monrath (W E-Sept. 22.) 800 w.

25251. Street Car Fenders (R G-Sept. 21.) 1600 w.

25288. Economy of Power House Operation. J. B. Craven (S R G-Sept. 22.) 2700 w.

*25349. Comparative Efficiency of Electric and Cable Tramways. Frank B. Lea (E E L-Sept. 14.) 1200 w.

*25352. The Economical Aspects of Electric Traction. Editorial (E R L-Sept. 14.) 1600 w.

25372. Underground Trolley for Street Cars. (S R E N-Sept.) 1100 w.

†25492. Electric Railway Construction in Philadelphia. Ill. (S R J-Oct.) 4000 w.

†25493. The Paterson, Passaic and Rutherford Electric Railway Company. Ill. Lemuel William Serrell (S R J-Oct.) 1100 w.

†25494. Graphical Records of Street Railway Statistics. Russell Robb (S R J-Oct.) 900 w.

†25497. The Perfection of the Electric Railway Motor. Lincoln Nissley (S R J-Oct.) 1500 w.

†25499. The Coming Convention at Atlanta. Ill. (S R J-Oct.) 6000 w.

25541. Compressed Air Tramway System in Paris. Ill. (S R G-Sept. 29.) 350 w.

25631. The Myrtle Avenue Improvement on the Brooklyn Elevated Railroad. O. F. Nichols (E N-Oct. 4.) 1800 w.

*25740. The Claret-Wuiblemier System of Electric Traction. Ill. (El-Sept. 28.) 1000 w.

25745. Street Regulations. Albert B. Weimer (S R G-Oct. 6.) 900 w.

†25781. The American Street Railway Association. Ill. (S R J-Oct.) 5000 w.

†25782. Atlanta, Her People and Her Industries (S R J-Oct.) 6000 w.

†25783. Principal Cities of the South and Their Street Railway Systems. Ill. (S R J-Oct.) 23500 w.

†25784. A Short History of the Street Railway Industry. Ill. (S R J-Oct.) 14000 w.

Serials.

21260. Electric Traction. C. H. Wilkinson (E P-Began April—Ended Sept.—5 parts—30 cts. each).

23795. The Lyons-Oullins Electrical Tramway. Ill. J. Berthon (E R L-Began July 13—3 parts to date—30 cts. each).

24308. The Florence and Fiesole Electric Railway (R P-Began Aug.—Ended Sept.—2 parts—30 cts. each).

24659. An Electric Railway System for London. Ill. J. H. Greathead (E Rev-Began Aug.—Ended Sept.—2 parts—30 cts. each).

24990. Joints for Girder and T-Rails and a Bond Adapted to each. Ill. James M. Price (S R G-Began Sept. 8—2 parts to date—15 cts. each).

25022. The Working Expenses of Electric and Cable Railways (R W-Began Sept.—1 part to date—30 cts).

25348. Mechanical Traction for Tramways (E E L-Began Sept. 14—2 parts to date—30 cts. each).

25599. Notes on the Management of Railway Power Stations. George T. Hanchett (E W-Began Oct. 6—1 part to date—15 cts).

SCIENTIFIC MISCELLANY

Evaporation from Water Surfaces.

MR. L. G. CARPENTER, Professor of Engineering in Colorado Agricultural College, has communicated to *Engineering News* an account of observations on evaporation from water-surfaces which have been carried on for six years at the college named, situated at Fort Collins, Colo. Under the title "Observations on Evaporation from Water Surfaces in Colorado," the journal quoted has printed Professor Carpenter's communication, which is of much practical importance to engineers, as illustrating methods of determining surface evaporation, and is also of general scientific interest.

Prof. Carpenter used a tank having a length, breadth and depth respectively of three feet, which he has made his standard. The upper surface exposed is, therefore, one square yard. This tank is placed in the ground. He also has used at intervals four or five small tanks for comparison, and has "had, for several years, tanks floated in lakes in a neighboring canal, and in a river, in such manner that they would have nearly the same temperature as the surface of the water in those places, and be exposed to the same conditions." Measurements in the standard tank were made by means of a hook gage which permitted readings less than thousandths of a foot. From April or May to September, two daily observations are made, and from and after Sept. 1, only one daily observation. Prof. Carpenter observes that after Sept. 1 the early sunset interferes with the second observation.

During the winter when the water is frozen, the observations are made but once or twice a month, which is done by completely separating the ice from the sides of the tank, and reading the surface height of the water as in the other observations. At the same time observations are also taken of the temperature of the water surface, temperature and humidity of the air, vapor tension, the movement of the wind, etc. During one season the temperature of the water 1 foot below the surface was also taken. Allowance is made for rainfall.

Prof. Carpenter states that the observations made have not been reduced for several years past, owing to stress of other work, and the editor of *Engineering News* justly remarks, after giving Prof. Carpenter's communication, that "the long period over which the observations have extended and the evident care with which they have been made render it very desirable that the results should be fully tabulated and published, both for local benefit and for the good of the engineering profession at large."

Besides what has been noticed in this important communication so far, it contains a great deal of useful information concerning the difficulties to be overcome and sources of error to be avoided in order to render the results of such observations trustworthy. Among essential points it is necessary that an accurate wind record should be kept. The determination of evaporation from surfaces according to Prof. Fuertes, is more difficult than the determination of rain fall; and this assertion is confirmed by Prof. Carpenter.

"It may be that this is largely true, because observers have too often expected to find the depth of the layer evaporated from a free water surface nearly the same throughout a given region and that the differences would be greater than are found with rain fall. It cannot be emphasized too much that evaporation is almost entirely a local phenomena. The amount depends almost entirely on the conditions of the special point. It depends not only on the moistness of the air, which may be fairly uniform over considerable areas, but particularly on the rapidity of the wind at the water surface or near by which serves to remove the saturated air, and the temperature of the water surface itself. These will vary according to the exposure, and the temperature will vary according to the amount of water, its surroundings, the depth and many other conditions, so that the difference of temperature in different bodies of water

in the same locality is often considerable. It is the temperature of the surface itself rather than of the body of water, which determines the rate, because the phenomenon is a surface one. It does not require any great difference of temperature to make a marked difference in the rate of evaporation. Thus in the course of a single month, the evaporation from a neighboring reservoir was at twice the rate of evaporation from our tank placed in the ground. The difference was almost entirely due to the warmer temperature of the water in the reservoir, and though this was but 10°, it was sufficient to account for the double rate, as shown by application of our formula. It is because of the varying temperature of each separate exposure that the evaporation is so variant even in the same locality. Accordingly the observations taken under one set of conditions will give results which may be very misleading if applied to other conditions, unless the effect of each element which enters can be allowed for."

Prof. Carpenter deems it of high importance in making observations that "the temperatures of the surface of the water be taken." He regards the Piche evaporometer as an unreliable indication of surface evaporation, and gives his reasons for this view. He expresses his opinion that most reports of observations or evaporation made in various places are "not very valuable, because the conditions of the observations have not been sufficiently given." On the whole, he regards Fitzgerald's observations as the best yet made. Fitzgerald's formula, is, however, based on hourly observations, which Prof. Carpenter regards as "generally impracticable under the conditions to which engineers are subject"; and he closes his interesting communication with a brief reference to the observations reported by Mr. J. D. Schuyler, and included in the report of the state engineer of California for 1878–89.

Where the Teak Wood Grows.

AN article of both scientific and practical interest, gracefully written by Marion Manville Pope, superbly illustrated, and printed in *The Century* for October, is one of the best contributions of its class to the literature of the month. To quote the language of the introductory paragraph, it takes the reader "into the heart of untrodden jungles, on thick-wooded hillsides, leaning over the brinks of precipices, where tropical creepers twist like snakes, choking the life out of younger growths, where orchids flaunt aloft, and strange flowers bloom,"—where the teak-wood grows. It not only gives its readers this delightful free excursion, but the society of a most agreeable companion who knows what will be of interest to those who have not been over the ground, and guides them to it.

The teak-wood tree (*Tectona grandis* is its botanical name—often also called the "Indian Oak," both the tree and its timber being called oak as well as teak by the author of the article) supplies probably the most valuable timber for many industrial purposes that grows on the face of the globe. It is heavier than water, and is hard and extremely resistant, not only to atmospheric influences, but to the attacks of insects.

That atom of animate destruction, the white ant, has passed it by. Other growths have reared their heads out of the jungle around it, have grown, have lived their day, died, and rotted back to the roots which supplied them with life. In comparison man has been a midget, a mote in the sun, hunting his fellow animals with flint-headed arrows and stone axes, flitting, passing, gone; but the great oaks have grown, have spread their arms benignantly over the dust of tiny shapes beneath, and, planted in dignity, have stood as emblems of strength and power in meditations lasting one, two, three, five, and six hundred years.

Yet, "out of these emblems of strength has grown a weakness that has overthrown a nation," says this pleasant writer; thereby implying that this valuable timber growth was a factor in bringing the Burmese under the British yoke.

The gathering of this timber store has been an industry ever since man of any color inhabited the country. Teak grows only in India and Burmah, and in old palaces and temples it has held indestructible place for many generations. From the color of sandal-wood it changes with age to walnut-brown. Big unpainted bungalows standing upon pillars of the wood, sided with it, shingled with it, latticed with it, defy heat and rain, and grow rich upon their poverty of oil and varnish. They stand, as brown as autumn, out of green compounds against summer itself. Vines wrap

them, flowers garnish them, years add moss and lichen, but nothing destroys save flame. Railroad car-wheels, spikes for laying track, pegs for bolts, implements of all sorts, are made of teak. No one save a shipwright knows just how many parts of a ship are built from this muscle of nature, but every one who has walked the deck of bark or steamer has a consciousness that no amount of holystoning, or dragging of cargo over, or wear and tear of feet and traffic, can in an ordinary sense affect a teak-wood floor.

The Burmese wood-carver knows his art is almost hewn in stone when he coaxes leaf and flower, sacred cow and festival-cart, grotesque sprites and elves, gods and Buddhas, out of rugged trunks. The little prow of the sampan shaped like a wishbone, the stern of a paddy-boat as brown with age as the naked figure upon it is with the elements, the strange plinths of stranger pillars, the embellishments of the temples, the playthings of the children—all these are carved from teak.

The teak lumber business is, we are told, a strange industry; and when it is presented to us so graphically by pen and pencil, and we are invited to contrast it with what we know of lumber gathering in Northern and Western lands, we realize that the word "strange" is not misapplied. We think of the derricks by which huge beams and logs are lifted and swung around to desired positions in English, Norwegian and American timber yards, and here in the teak-yards to which we have been transported, we see living derricks doing the same work—trained elephants grasping heavy timbers with their trunks, and placing them as desired, each obeying the directions of a bare-waisted, bare-legged, dusky *mahout* (our guide here explains that the Burmese for *mahout* is *oozee*) stepping over and between other timbers strewn about the yard, and using tusks as well as trunks and their broad foreheads as the exigencies of their tasks demand.

To any one for whom machinery has a fascination there is nothing stranger than the first glimpse of elephants at work about it. Amidst the hissing swish of belting, the buzz of saws, the multitudinous separate rattles mingled into a universal roar and vibrating through a big sawmill, the ponderous figures of these slow-paced helpers present a curious sight. One elephant places the log upon a movable platform to be squared, while another waits with restless eyes and flapping ears until the saw has done its work, and then, taking a twist in an attached rope, slips the loop of it deftly over a big tusk, and leads the log away. Another piles timber, lifting the long piece between tusks and trunk, and pushing it into place with the latter if the pile is low, or with a broad forehead if the height demands it. Fetching and carrying, lifting and stacking, pushing and pulling, these docile and patient giants do their work without complaint, week in and week out.

The reviewer reluctantly leaves this delightful article, hoping by the quotations made from it that he has been able measurably to indicate its character. Much interesting information is given in it, especially as regards the care which all civilized nations, except the United States, are bestowing upon the systematic conservation of their forest wealth.

The Vaccination of Land.

SOME editorial notes printed in the *American Architect* upon this curious process have been run together and printed as one continuous paper in the *Scientific American*. If all that is asserted regarding the process prove to be true it will result in incalculable benefit to agriculture and to the human race. The process is the logical outcome of some of the most remarkable agricultural experiments ever made which have been fully described in *Le Genie Civil* from which the *American Architect* derived the information contained in the editorial notes referred to. If the results of the experiments are in every respect as stated, it is impossible to exaggerate the importance of the discovery which has been made. It is impossible here to give a full résumé of these experiments, or the results alleged to have been attained. The statements are, however, made on high authority, and until disproved their credibility must be accepted. The discovery is in line with many others which have been made in recent times through researches in bacteriology.

For a long time it has been known to agriculturists that rotation of crops has had a renovating influence upon the soil; but up to a recent period the cause of this

effect has eluded investigation. Chemical analysis has seemed to show that the land cultivated in this way gained nitrogen; and it has been supposed by many that certain plants possessed the power of absorbing nitrogen and imparting it to the soil in some form which enabled it to be retained for the nourishment of subsequent crops. Very thorough investigation by eminent scientists failed, however, to confirm this theory; and finally the consensus of scientific opinion became opposed to the belief that any plant, of whatever kind it might be, could act in this way. Nevertheless the experience of farmers in the rotation of crops still maintained the belief that some agency thus brought into play restores nitrogen to soil which has been impoverished by previous crops. Thus the matter stood until the problem was attacked by Hellriegel and Willfarth "who demonstrated beyond question that the leguminosæ in growing do absorb large quantities of nitrogen from the air, but with the singular condition that this absorption of nitrogen begins only with the appearance of a diseased state, which is marked by the development of tubercles about the size of a millet seed on the roots, and is, apparently, caused by minute animals which are always found in the tubercles, and seem to give the plant the nitrogen absorbing power.

Further investigations showed that the young, healthy plants lived on the nitrogen already contained in the soil, and that it was not until this was exhausted, and the plants began to suffer, that the nitrogen absorbing excrescenoes made their appearance; and, proved, also, that the tiny inhabitants of the tubercles were, as a rule, confined to one species of plant, the acacia microbe, for example, refusing to live on the bean, or the clover microbe on the lentil.

It is evident that a plant capable of absorbing nitrogen, which is a costly as well as indispensable adjunct to farming, and of storing it up in the soil for its master's profit, is a valuable possession; and, as only diseased plants have that property, it is obvious that it is desirable to spread the nitrogen-storing disease. With this view, several skillful farmers in France and Germany have, within the past two or three years, been trying experiments, by "vaccinating," as they say, fields of leguminous plants, by sprinkling them with earth in which tuberculous plants have been growing, or water in which they have been soaked; and the results have been extraordinary. Analysis has shown that a single crop of tuberculous leguminosæ, if the tops are plowed in, adds to the soil from five to twelve thousand pounds of nitrogen, worth from eighteen to forty-five dollars, to the acre; and even when the tops are cut and carried away, there is enough nitrogen left in the roots to insure a good crop of cereals on the same ground the next season, without other fertilizer.

Following up this line of experiment, the results alleged to have been obtained with various crops is altogether so extraordinary as to almost stagger belief, but for these the reader must consult the article itself. It may yet prove that the land available for cultivation in the world will be sufficient to sustain a very much larger population than has hitherto been supposed possible by students of the subject.

The Granary of the Continent.

IN an interesting illustrated but unsigned article written for *Milling*, a deserved tribute is paid to the influence upon the development of the great grain producing regions of the western United States which has been exerted by the writings of trained journalists, among whom are named Horace Greeley, Samuel Bowles, Albert D. Richardson, Henry Villard, Thomas W. Knox and William Phillips, a galaxy of honored names in the history of American journalism. But in dealing with other elements which have coacted to accelerate a progress unparalleled in the world's history, the writer puts himself in closer touch with the industrial interests to which this magazine is devoted.

First the pioneer element of hardy adventurers, exploring, discovering, and telling to the civilized world behind them the enormous resources that lay beyond. Then the railroads piercing the wilds soon to be brought into the sisterhood of States. And last, but not least, the advent of improved agricultural machinery. These are the forces whose combined effect has been to populate a region large enough for a dozen kingdoms; to make it the food producing region for a large part of the world; to

cover its lakes and rivers with swift floating commerce; to dot its broad fields with white-spired prosperous villages, and to rear on its centers of trade large and populous cities whose growth has amazed the old world.

A comparison between the small farms of the east "where small farms are the rule," and the broad grain fields of the west, "where small farms are the exception," is made. The illustrations of powerful harvesting machinery, some of which require teams of from 25 to 30 horses to draw them, and other harvesting scenes presented in the illustrations reprinted from the *Northwest Magazine*, are pictures of what can be seen nowhere in the world except in the great "granary of the west." And when it is remembered that this giant progress would have been utterly impossible but for the resources which science has placed at the command of mechanical skill and genius, still only a very partial and meager conception of what science has done, is doing, and is destined to accomplish for the human race, will be gained. "Eye hath not seen nor ear heard," nor yet has the mind of man conceived what is in store for future generations, when hearts now living shall be stilled, and the eyes that now see dimly some little part of what is to be, shall have closed forever.

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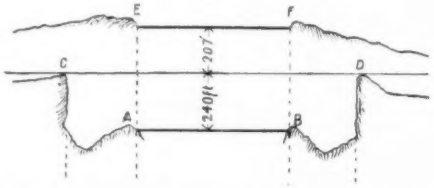

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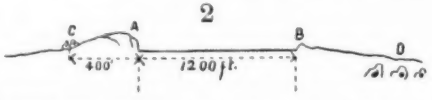


The Recent Eruption in the Crater of Kilauea.

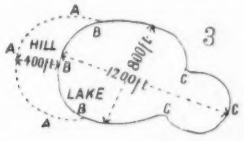
AN extremely interesting article under the above title is printed in *The American Journal of Science* for October. A description of the eruption is given by L. A. Thurston, and is copied from the *Pacific Commercial Advertiser* of July 23, 1894. He states that the great lava lake in the southern extreme of Kilauea Halemaumau has been steadily rising since the last great discharge in March, 1891, when an area 2500 feet long by 2000 feet wide sunk in one night a distance of over 500 feet. "The rising and overflowing of the lake filled this pit last fall; since that time the activity of the lake has been intense, as many as twenty-three overflows of liquid lava having taken place in a single day, and the walls surrounding the lake have been rapidly raised by continued overflows."

He states that accurate measurements of the lake were made by Mr. F. E. Dodge of the Survey Department in August, 1892 and March, 1894. Mr. Dodge has reported in the Volcano House book the result of these observations. The profile view of the lake at the two periods is shown in Figure 1. A B, level Aug. 1892; C D, rim of pit, 1891, E F, surface level March, 1894.

Upon arriving at the volcano on July 5, 1894, the principal change since Mr. Dodge was there was found to be the sudden rising of the north bank of the lake, covering an area of about 800 feet long by 400 wide, which, on the 21st of March last was suddenly and without warning elevated to a height of 80 feet above the other banks and the surface of the lava, the lake being then full. The raised area was much shattered, and two blowholes shortly afterward made their appearance on the outer line of fracture. On the 18th of April the hill thus formed began to sink, and on July 5th was only about 30 feet above the other walls of the lake. On the evening of the 6th of July a party of tourists found the lake in a state of moderate activity, the surface of the lava being about 12 feet below the banks. On Saturday, the 7th, the surface of the lake raised so that the entire surface was visible from the Volcano House. That night it overflowed into the main crater, and a blow-hole was thrown up some 200 yards outside and to the north of the lake, from which a flow issued. There were two other hot cones in the immediate vicinity which were thrown up about three weeks

before. On Sunday, Monday and Tuesday, July 8th, 9th and 10th, the surface of the lake rose and fell several times, varying from full to the brim to 15 feet below the edge of the banks.

Figure 2 is a diagram exhibiting the condition of surface of the lake on Tuesday night, July 10th, of the same year. Figure 3 illustrates the outline of the lake and the position of the hill mentioned in the paragraph quoted as surveyed on the morning of the 11th July.



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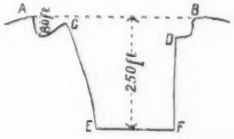
The lava in the lake continued to fall steadily, at the rate of about 20 feet an hour from 10 o'clock in the morning until 8 in the evening. At 11 A. M. the area formerly occupied by the hill, marked A, A, A, in the diagram, began to sink bodily, leaving a clean line of fracture ; the line of this area, marked B, B, B, was continuously leaning over and falling into the lake. From about 12 until 8 in the evening there was scarcely a moment when the crash of the falling banks was not going on. As the level of the lake sank, the falling rocks of the banks, undermined by the escape of the lava, caused a constantly increasing commotion in the lake as they struck the surface of the molten lava in their fall.

The following is also quoted from this interesting description of a convulsion whose grandeur is scarcely conceivable :

About noon the sinking lava disclosed the fact

4

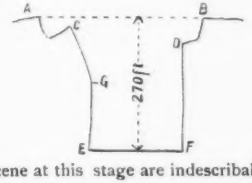


that the small extension at the right of the lake was only about 80 feet deep, and it was soon left high and dry, simply a great shelf in the bank, high up above the surface of the lake. As the lava subsided, most of the surrounding banks were seen to be slightly overhanging, and as the lateral support of the molten lava was withdrawn, great slices of the overhanging banks on all sides of the lake would suddenly split off and fall into the lake beneath. As these changes took place the exposed surface, sometimes 100 feet across and upward, would be left red hot, the break evidently having taken place on the line of a heat-crack which had extended down into the lake.

About 6 o'clock the falling bank adjacent to the hill worked back into a territory which, below 50 feet from the surface, was all hot and in a semi-molten condition. From 6 to 8 o'clock the entire face of this bluff, some 800 feet in length and over 200 feet in height, was a shifting mass of color, varying from the intense light of molten lava to all the varying shades of rose and red to black, as the different portions were successively exposed by a fall of rock and then cooled by exposure to the air. During this period the crash of the falling banks was incessant. Sometimes a great mass would fall forward like a wall ; at others it would simply collapse and slide down making red hot fiery landslides ; and again enormous bowlders, as big as a house, singly and in groups, would leap from their fastenings, and, all aglow, chase each other down and leap far out into the lake.

The awful grandeur and terrible magnificence

5



of the scene at this stage are indescribable. As night came on, and yet hotter recesses were uncovered, the molten lava which remained in the many caverns leading off through the banks to other portions of the crater, began to run back and fall down into the lake beneath, making fiery cascades down the sides of the bluff. There were five such lava streams at one time.

The almost entire absence of sulphurous vapors is one of the peculiarities of this eruption noted. No difficulty in breathing was experienced directly to the leeward of the lake. At 8 o'clock in the evening the profile was approximately that shown in Figure 4, and Figure 5 exhibits it as it appeared at 9 o'clock in the morning of July 12.

A very meager impression of the interest of this article is conveyed by this review. It seems impossible to leave out any part of the paper without defeating the intention to represent it at its full value, both scientifical, and as a popular description of a grand and interesting event.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*24945. Causes and Effects of Forest Fires. John Gifford (E Mag-Nov.) 3000 w.

*24946. The Land of the Mikado. J. Castell Hopkins (E Mag-Nov.) 3000 w.

*24951. Past and Present of the Whaling Industry. Ill. Herbert L. Aldrich (E Mag-Nov.) 3000 w.

24966. Rain-Making Down to Date. J. R. Sage (W A-Sept.) 1800 w.

24981. Plans to Improve Future Transportation. Editorial (A M & I W-Sept. 7.) 800 w.

†24998. Notes on the Pleistocene of the North-west Territories of Canada, North west and West of Hudson Bay. J. Burr Tyrrell (G M-Sept.) 2500 w.

†25000. The Most Recent Changes of Level and Their Teaching. The Rapid Collapse of Some Districts at the Close of the Mammoth Age. Henry H. Howorth (G M-Sept.) 4400 w.

25013. The Eddy Malay Tailless Kite. Ill. (Sc A-Sept. 15.) 1800 w.

25052. Sea Salts and Carbonates. J. A. Dewe (Sc A S-Sept. 15.) 5700 w.

25055. The Sinking of the Kow Shing (A & N J-Sept. 15.) 900 w.

25076. The Cryolite of Greenland. Francis H. Knauff (M & B-July.) 900 w.

†25084. Tire Protectors: Have They a Future? (I R W-Sept. 15.) 1200 w.

†25085. Some Features of the Pará Rubber Trade (I R W-Sept. 15.) 900 w.

†25086. Our Warning from the Naval Manœuvres. William Laird Clowes (N C-Sept.) 7000 w.

†25088. The Question of Korea. Henry Norman (C R-Sept.) 5600 w.

†25090. Possible Developments in Naval Armament. James Eastwick (C R-Sept.) 2800 w.

*25111. The Diffusion of Light by Dull Surfaces. Christian Wiener (El-Sept. 7.) 4000 w.

*25122. The Distribution of Compressed Air in Paris. Ill. (E-Sept. 17.) 1500 w.

*25127. A Direct Reading Form of Platinum Thermometer. G. M. Clark (E-Sept. 7.) 2000 w.

†25141. Leonardo da Vinci as a Pioneer in Science. William R. Thayer (Mo-July.) 13000 w.

†25144. Notes on Aërial Navigation. V. E. Johnson (W R-Sept.) 3300 w.

*25148. Kite and Kite Flying, as Applied to the Study of Meteorology, Wind Pressure and Aeronautics. V. E. Johnson (Inv-Sept. 8.) 2700 w.

*25149. Artificial Silk; or the Silk-Worm Superseded (Inv-Sept. 8.) 1200 w.

*25157. Japanese Inlay (I C B-Sept. 7.) 1400 w.

*25158. Mosaic Inlay and Buhl (I C B-Sept. 7.) 1200 w.

25160. The Salt in the Sea and Where It Goes. (Extract) J. A. Dewe (M Rec-Sept. 13.) 1400 w.

25161. Age of Niagara Falls (M Rec-Sept. 13.) 1500 w.

25180. Microbes Purify Water (F W-Sept. 15.) 1500 w.

†25200. The Professional Training of Teachers. M. V. O'Shea (P S M-Oct.) 5000 w.

25214. Rates of Precipitation in Rain Storms at Ithaca, N. Y. James H. Fuertes (E N-Sept. 20.) 800 w.

25219. A New German Military Balloon. Ill. (Sc A S-Sept. 22.) 300 w.

25222. The New Gas. (Sc A S-Sept. 22.) 600 w.

25226. Along the Coast of Kent. W. H. Booth (A M-Sept. 20.) 2400 w.

*25241. The Difference in Amount of Radiation Required in Buildings of Good and Poor Construction. E. P. Bates (D E-Sept.) 3500 w.

*25253. Japanese and Chinese Porcelains and Their Imitations. Saburo Arai (L Mag-Oct.) 1200 w.

*25271. Report on the Waltham Abbey Explosion. Editorial (Eng L-Sept. 14.) 1300 w.

25297. Fuel Economy. Editorial (A M & I W-Sept. 21.) 800 w.

25300. How to Extinguish an Oil Fire in a Cellar. C. F. Wall (F W-Sept. 22.) 1200 w.

25303. Patenting a Flying Machine. Letter of Hiram S. Maxim (B J C-Sept. 22.) 900 w.

*25318. Hermann von Helmholtz. Editorial (El-Sept. 14.) 1500 w.

*25323. Santa Fé as a Field for Emigration (B T J-Sept.) 1800 w.

*25326. Tariff Changes and Customs Regulations. Russia, Belgium, Spain, Portugal, China, Japan, Peru, West Africa, etc. (B T J-Sept.) 5500 w.

*25350. The Latest Views on the Problem of Mechanical Flight (Inv-Sept. 15.) 1500 w.

*25367. Hermann von Helmholtz (N-Sept. 13.) 1600 w.

25371. Origin of Gold. Editorial (M I T-Sept. 20.) 1500 w.

25385. Notes from the Antwerp Exhibition (Sc A-Sept. 29.) 1800 w.

25386. The Vaccination of Land (Sc A-Sept. 29.) 1000 w.

25387. Speaking Watches. Ill. (Sc A-Sept. 29.) 700 w.

*25399. The Significance of the Japan-China War. Michitaro Hisa (F-Oct.) 5000 w.

†25401. Astronomy and Religion. Edwin Arnold (N A R-Oct.) 4200 w.

25411. Decimal Time (E N-Sept. 27.) 1100 w.

We supply copies of these articles. See introductory.

25415. Observations on Evaporation from Water Surfaces in Colorado. L. G. Carpenter (E N-Sept. 27.) 1200 w.

*25453. Experiments in the Liquefaction of Hydrogen (C G-Sept. 21.) 1400 w.

*25471. Engineers of To-Day and Yesterday. Hamilton G. Castner. Ill. (E Rev-Sept. 20.) 1800 w.

*25477. The Tell-el-Amarna Tablets (A L-Sept. 21.) 3000 w.

*25488. Geologies and Deluges. Address of Prof. Sollas (N-Sept. 20.) 8500 w.

*25490. Science at the Beginning of the Nineteenth Century. Paul Carus (Ch-Oct.) 4200 w.

*25519. The Granary of the Continent. Ill. (Mill-Sept.) 1300 w.

†25532. Where the Teakwood Grows. Ill. Marion Manville Pope (C M-Oct.) 2000 w.

*25537. A Standard of Efficiency for Engineers (P Eng-Sept. 21.) 1800 w.

†25544. Methods and Apparatus for Drying with Heated Air. E. M. Cook (P E C P-April-June.) 6000 w.

†25548. An Auriferous Conglomerate of the Jurassic Age from the Sierra Nevada. W. Lindgren (A J S-Oct.) 2400 w.

†25549. On the Double Chlorides and Bromides of Caesium, Rubidium, Potassium and Ammonium with Ferric Iron, with a Description of Two Ferro-ferric Double Bromides. P. T. Walden (A J S-Oct.) 1500 w.

†25552. Notes on the Miocene and Pliocene of Gay Head, Martha's Vineyard, Mass., and on the "Land Phosphate" of the Ashley River District, South Carolina. William H. Dall (A J S-Oct.) 1700 w.

†25553. On the Thermo-Electric Properties of Platinoid and Manganine. B. O. Peirce (A J S-Oct.) 1400 w.

†25556. On the Age of Manganese Beds of the Batesvilie Region of Arkansas. Henry S. Williams (A J S-Oct.) 2500 w.

†25557. The Present Status of High Temperature Research. Carl Barus (A J S-Oct.) 1100 w.

†25558. The Recent Eruption of the Crater of Kilawea. L. A. Thurston (A J S-Oct.) 1700 w.

25571. How to Save the Palisades (G & F-Oct. 3.) 1100 w.

25625.—$1.50. A Few Remarks about the Niagara Gorge. Ill. L. L. Buck, with Discussion (T C E-Aug.) 3500 w.

†25642. Nanno, a New Cephalopodan Type. Ill. J. M. Clarke (A G-Oct.) 1100 w.

†25643. The Relation Between Base leveling and Organic Evolution. J. B. Woodworth (A G-Oct.) 9500 w.

†25644. Tertiary and Early Quaternary Base-leveling in Minnesota, Manitoba and Northwestward. Warren Upham (A G-Oct.) 4000 w.

25669. Apparatus for the Determination of Temperature in Glass Furnaces (A M & I W-Oct. 5.) 2000 w.

*25673. The West Point Soldiers' Monument. Ill. (E-Sept. 28.) 2300 w.

*25676. The Naval Battle. Editorial (E-Sept. 28.) 1800 w.

25701. Electricity as a Fertilizer (L A-Sept.) 700 w.

25711. Are We Ruined by Science? The Deterioration of Man Under Its Influences (B J C-Oct. 6.) 2500 w.

25721. Ancient Monuments.—Choragic Monument of Lysicrates at Athens. Ill. (Ml N-Oct.) 500 w.

*25748. Aeronautic Engineering Materials. (Reprint from Cassier's Magazine.) R. H. Thurston (P Eng-Sept. 28.) 4000 w.

Serials.

21763. Engineering Practice and Education. Gaetano Lanza (J F I-Began May—6 parts to date—45 cts. each).

23443. Sculptured Monuments of Boston. Ill. Frank T. Robinson (Ml N-Began July—4 parts to date—15 cts. each).

24240. On Some Life Zones in the Lower Palaeozoic Rocks of the British Areas, as Defined Mainly by Researches During the Past Thirty Years. Henry Hicks (G M-Began Aug.—2 parts to date—45 cts. each).

24462. Graphic Statics. Ill. W. W. F. Pullen (P Eng-Began Aug. 10—5 parts to date—30 cts. each).

24777. The Detection and Estimation of Small Quantities of Inflammable Gas or Vapor in the Air. Ill. Frank Clowes (J S A-Began Aug. 24—4 parts to date—30 cts. each).

24997. On a Collection of Jurassic Cephalopoda from Western Australia, with Descriptions of the Species. Ill. G. C. Crick (G M-Began Sept.—1 part to date—45 cts).

25168. Ancient and Modern History of Petroleum and the Mechanism to Determine Its Value as a Lubricant. Abraham W. Harris (M G-Began Sept. 15—Ended Sept. 22—2 parts—15 cts. each).

25280. Wood Pulp, and Its Conversion into Paper and Other Products (I & I-Began Sept. 7—4 parts to date—30 cts. each).

25313. The Manufacture of Briquette Fuel-William Colquhoun (I C T-Began Sept. 14—3 parts to date—30 cts. each).

25654. Aërial Navigation. A. F. Zahm (J F I-Began Oct.—1 part to date—45 cts).

25664. Letters to Young Engineers on Graphic Statics. Ill. E. G. I. McCudden (I E-Began Sept. 1—1 part to date—45 cts).

NEW BOOKS OF THE MONTH

A TEXT-BOOK ON ORE AND STONE MINING. By C. Le Neve Foster, D. Sc., F. R. S., etc. Philadelphia: J. B. Lippincott Co. London: Charles Griffin & Co., Ltd. [Cloth, large 8vo, xxviii–744 pp., 717 illustrations. $10.]

THERE are many general treatises on mining, having all gradations of merit, and of them this latest addition is one of the very best. The main difficulty in compiling a work of this kind is the wide extent of the field to be covered and the great diversity of the sub-topics into which the discussion ramifies. In the present case the author has met this difficulty as well as may be by occupying rather more than the usual space, thus being enabled to go from principles to examples in practice, and his selection of matter has been generally judicious, though it seems impossible for any writer on mining to avoid describing many things that are obsolete or obsolescent and on the other hand omitting many new features. The latter point applies especially to mining machinery, in which progress is continuous and so rapid that it would of course be hopeless to attempt to include everything new that is of value; and even if that were possible at any given date, a book so comprehensive would soon become a mere record, a sort of milestone on the track of progress, and would need to be supplemented from time to time by later and later additions. In essential principles the art of mining changes very little from one period to another, so that in this respect any one of the standard works (among which the present will take a high rank) is a fairly safe guide; whereas in details the treatises on special branches, the contributions to the various engineering societies and the technical periodicals must be constantly consulted by those who would keep pace with the times. Still, Mr. Le Neve Foster has managed to include a great deal of recent practice, and the reader will find in this book frequent references to events, discoveries and inventions down to as late as the year 1893, showing that in getting together his material the author has not lost sight of what is going on.

The standpoint of the author as to the true function of mining literature is wholly sound, and the idea thus expressed in the preface is kept in view throughout.

> Books and lectures are not intended to take the place of practical teaching [experience?] at mines; but they render the training more thorough and complete in many ways; they serve to explain the principles of the art, to solve difficulties which perplex the beginner, to suggest matters which he should observe, to tell him of those beyond his ken, and to supply him with a system for arranging his ideas methodically.

If all the makers and all the users of books on mining, and indeed on any technical subject, would regard the utility and limitations of such works in this light, there would be less disposition on the part of "practical" men to belittle book knowledge—a tendency which, however, is passing away.

The scope of this text-book is very wide—wider in fact than is often attempted. Besides the main subdivisions which one would naturally look for in such a book, there are chapters on the principles of employment of mine labor, on legislation affecting mines and quarries, on the condition of the miner (as to clothing, housing, education, etc.), and on accidents. Ventilation, which is usually touched upon lightly or relegated to books on coal mining, is given considerable prominence. The geological introduction (87 pages) contains a rapid survey of the common occurrence of minerals, and is followed by a chapter on indications in prospecting. The body of the book is arranged on the usual models of classification.

The author has endeavored to avoid restricting his work to the requirements of the British miner, and makes frequent citations of continental and Australian practice, with occasional mention of Amer-

ican systems; yet it was inevitable that a tinge of Cornish and Welsh methods—very sound, if not very progressive methods they are—should not have resulted from his environment and more special personal study.

This book, it will be noticed, includes "stone mining"; in fact almost everything except strictly colliery work. Besides the metals and metallic ores this means the occurrence and means of gaining a long list of mineral substances, such as building stone, slate, clays, flint, barytes, mica, diamonds, alum, amber, asbestos, graphite, gypsum, phosphates, sulphur, asphalt and ozokerite, various salts, petroleum, natural gas—and even ice. It will be easily understood that a large book could be written on either of these specialties, so that in a general work there is not much room for any single one of them. Then there is a long chapter on dressing, concentration and the preparation of minerals at the mine for sale or reduction.

The numerous footnote references to the literature of the subject are a useful feature. By following them up the reader who wishes to get fuller information and go more deeply into details will know where to look for what he wants. A. W., JR.

STANDARD WIRING FOR ELECTRIC LIGHT AND POWER. A Compilation of Formulæ, Rules and Requirements from the most Modern Practice, and in Accordance with the Rules and Requirements of the Boston Fire Underwriters' Union, the New England Insurance Exchange, and as Recommended by the Underwriters' International Electric Association. By H. C. Cushing, Jr., Electrical Inspector. Boston. Published by the Author. [12mo, roan, 62 p., illus. $1.]

IT is for many reasons eminently desirable that a work on electric wiring and construction should be written by an experienced insurance inspector. The inspector is a person who looks at the matter primarily from the standpoint of safety, and only secondarily from the standpoint of economy; but it is nevertheless true that in the long run the highest economy results from and is promoted by, absolute safety. Mr. Cushing has given, in compact and convenient form, an excellent résumé of the whole subject; including the proper installation of dynamos, motors and lamps, both arc and incandescent, outside construction and inside wiring, and a selection of approved tables and formulæ sufficient for the ordinary requirements of an installing engineer. These rules are in the main the same as those contained in the manuals issued by the General Electric Company for the instruction of its employés. Few questions are likely to arise in the mind of a wireman or engineer, as to just what construction will be regarded as safe by insurance people, which cannot be readily answered by reference to this handy little manual. The standard of outside construction called for may fairly be said to be in accordance with what at the present time passes for the best class of work in this country, but is nevertheless in many respects far below that which ought to be insisted upon to-day and which will in all probability be required ten years hence. The day will come when the unmechanical wooden cross-arm and wooden insulator pin, together with the uninsulating glass insulator will be relegated to the limbo of oblivion, and such futile devices for the "insulation" of 1000-volt currents from the exterior walls of a building as those illustrated at A and B on page 25 of Mr. Cushing's work will be extinct beyond possible resurrection. Insurance inspectors, and more particularly electrical engineers, should never for one moment forget that the first requisite of good construction is insulation; the second is insulation and the third is also insulation, and that the fundamental requisite of an insulator is that it shall insulate, not only in dry but in wet weather. FRANKLIN L. POPE.

BUILDING SUPERINTENDENCE. By T. M. CLARK. 12TH Edition. Macmillan & Co. 1894.

THE book before us was originally published by James R. Osgood & Co. about fourteen or fifteen years ago, and as far as can be determined by a general comparison, the present edition is from the same stereotype plates as the first, without a word of revision or any effort to bring it up to date.

This is a very serious defect in any practical handbook, and is especially unfortunate in a book designed as a practical guide to beginners in architectural super-

intendence. The only way in which the superintendent of a building in course of construction can hope to make himself useful to his employer, the architect or the owner, is by being thoroughly well primed as to what work is contemplated by the drawings and specifications, and ready to give chapter and verse to the builder or the mechanic for an objection he may make or change he may order. Now Mr. Clark kept this well in mind, and wrote a very useful book, clear, concise and well arranged, and showing great discretion in following his subjects just far enough to put his readers on their guard, without confusing them, if beginners, with too many details and minor points. When this book was first written it was accepted by the profession generally as a standard work, and was very widely used.

Since that time, however, more new inventions have been adopted and more departures made in the materials and methods of construction than were seen in the three hundred years preceding, and the book as it stands to-day before us would be really dangerous in the hands of a beginner, owing to what it omits to mention.

It would be impossible to point out all its omissions without taking too much space, but in running over the book the following points "sautent aux yeux." The references to other text-books omit all the more recent works, such as Berg's and Hill's on modern fireproof construction, Waring or Gerhart on modern plumbing and sanitation, and no reference is made to electricity either for light or power. None of this had been done when Mr. Clark first wrote, but it is an old story to-day.

Redwood and cypress are not mentioned, nor are tile linings for chimneys, tile copings for walls, creosote or other stains for shingles, metal lathing, the various patent plasters, open fixture plumbing and the endless variety of all porcelain fixtures, steam and hot water heating, plaster-relief work, spring door checks, transom lifts, elevators, hard oil finish, electric lighting, and wiring for it, iron skeleton construction, foundation work for tall buildings, artificial stone for side-walks, etc., many forms of structural iron, telephones, typewriters, blue prints, mail chutes and many other things now in general use, were either unknown or rarely used when Mr. Clark first wrote, but it seems hardly fair to him or to those who may purchase the book before us, to date it 1894 and describe it in the sub-title as a "Manual for young architects, students and others interested in building operations *as carried on at the present day*." The italics are ours.

ENGINEERING CONSTRUCTION IN IRON, STEEL AND TIMBER. By William Henry Warren, M. I. C. E., A. S. C. E., professor of civil and mechanical engineering, University of Sydney, N. S. W. London and New York: Longmans, Green & Co. [Cloth, large 8vo, xi-370 p., with numerous diagrams and folding plates. $5.]

THIS latest treatise on engineering construction is in entire harmony with the tendency evinced in the best recent text-books on all branches of engineering, to amplify and illustrate the discussion of underlying principles by introducing many practical applications by way of example—a system which relieves the monotony of the theoretical and mathematical discussion, quickens the reasoning faculty and makes plain what the mere enunciation of principles and formulæ fails sometimes to do. In another direction, the frequent introduction of graphic statics, the later text-books mark a great advance upon the older, and are clearer as to computations and design. The present work is intended not only for the use of students in civil engineering, but also for those engaged in the design of constructional iron and steel work.

The plan of the work includes the following leading topics: the strength and other characteristics of the materials discussed, with the methods and results of tests; determination of stresses; bending moments and shearing stresses; resistance moments, and intensity of various stresses; examples of small bridges and viaducts in metal and timber; graphic statics applied to the determination of stresses in structures; braced girders with parallel flanges; bowstring and polygonal girders; deflection of beams; continuous girders; columns; plates and bars, joints and con-

nections; bridge decks; weight of main trusses and girders; plate web-girder deck bridges and through bridges; American truss bridges; wind pressure; braced piers; road bridges; swing bridges; arched and suspension bridges, etc. This partial list of topics indicates the wide scope of the treatise. The author proposes to supplement this book with a companion work on construction in brickwork, masonry and concrete, which will then round out the present treatise by adding the subject of foundations, so intimately associated with bridge construction.

In connection with the discussion of the fatigue of metal under repeated stresses, about which a good deal has been printed in this Magazine, it is interesting to note that Professor Warren followed the lead of Wöhler, Bauschinger and other experimenters, and from the recorded tests deduces an approximate ratio of vibrating strength to primitive strength to statical strength of 1: 2: 3. By "primitive strength" is meant the ultimate breaking point of a piece subjected to a load which is entirely removed before being reapplied.

A TEXT-BOOK ON ROADS AND PAVEMENTS. By FRED P. Spalding, Assistant Professor of Civil Engineering in Cornell University. M. Am. Soc. C. E. First edition; first thousand. New York: John Wiley & Sons. [Cloth, 12mo, viii-213 p. Illustrated. $2.]

ANIMAL traction, by common consent, is doomed, even for country roads, in thickly settled regions; but the exact period at which it is to be done away with seems to be based on a sliding scale that reaches far into futurity. So far as can be foreseen in the light of recent progress the ultimate development of systems of transportation will be in the direction of economical feeder lines, either operated by steam or by electric-power transmission, or by both, culminating in a network which will make every farm and every country residence a railway station or terminus. But that millennial epoch is by no means yet in sight. For the immediate present there is an urgent demand for improved roads, and it is being earnestly pushed by the bicycle-manufacturing companies, the horse-breeders, the press, and lately has been caricatured by the Coxey crusade.

For the paving of city streets it may at last be said that we have reached fairly definite conclusions, depending upon the traffic conditions and only vitiated by the uncertain factor of funds available. Professor Spalding brings out very clearly the principles which should guide in the choice of road and street material and construction. As to country roads the comparison he draws between the macadam and telford systems is especially instructive; while in the line of street paving the author scrupulously distinguishes between the ideal and the practicable. If an adverse criticism may be ventured in regard to a work so excellent otherwise, it would be to remark that Professor Spalding perhaps carries his conservatism to such a degree in the praiseworthy attempt to fairly state all sides of a question, whenever there is more than one side, that he occasionally leaves the reader in some uncertainty as to the author's own preference.

The book is arranged in numbered sections. Some idea of its scope may be had from the following outline of topics, each of which forms the subject-matter of a separate chapter: general considerations; drainage of streets and roads; location of country roads; improvement of country roads; broken-stone roads; foundations for pavements; brick, asphalt, wood and stone-block pavements; laying out city streets.

In regard to the improvement of our common roads Professor Spalding strikes the keynote of progress by declaring that such improvement "must come through transferring the work to the charge of those who make it a profession, and not through teaching the public how roads should be constructed." Public interest is pretty thoroughly aroused as to the importance of the subject. It remains now to remove the road-building supervision and maintenance from the hands of county commissioners and boards, chosen for political motives and purposes, to the engineering profession, where they properly belong And it may be remarked here that for

young students of civil engineering who are searching for a likely specialty there are few openings more promising just now than that of roads and paving, which line has only recently begun to be taken up as a regular profession, after having been neglected for about two thousand years, or since the period of the eminently practical Roman engineers.

BOOKS RECEIVED.

Bower, John A.=Simple Experiments for Science Teaching, Illustrating Elementary Physics and Chemistry. New York: E. & J. B. Young & Co. [Cloth. 12mo. 164 p. $1.]

Bowne, Thomas H.=A Few Hours' Talk with a Railroad-man. New York: Bowne Publishing Co. [Cloth. 12mo. 135 p. $1.]

Carwardine, *Rev.* William H.=The Pullman Strike [stating the side of the employes]. Chicago: C. H. Kerr. [Paper. 12mo. 135 p. 50 cents.]

Clauder, H. T.=What Time is It? A Manual of Instruction in Teaching and Reckoning Time, Longitude, etc. New York: W. Beverley Harison. [Paper. 12mo. 39 p. 30 cents.]

Drage, Geoffrey.=The Unemployed. New York: Macmillan & Co. [Cloth. 12mo. 277 p. $1.50.]

Earl, Alfred.=Practical Lessons in Physical Measurement. (Manuals for Students series.) New York: Macmillan & Co. [Flex. cloth. 12mo. 350 p. $1.25 *net.*]

Gifford, John B.=Elementary Lessons in Physics. Illustrated. Boston: Thompson, Brown & Co. [Cloth. 12mo. 8-161 p. 60 cents.]

Harper, Charles G.=Practical Handbook of Drawing for Modern Methods of Reproduction. Illustrated. Philadelphia: J. B. Lippincott Co. [Cloth. 8vo. 12-161 p. $2.50.]

Hobson, John A.=The Evolution of Modern Capitalism: a study of machine production. (Contemporary Science series.) New York: [imported by] Charles Scribner's Sons. [Cloth. 12mo. 15-388 p. $1.25.]

Hornby, John.=The Gas-Engineer's Laboratory Handbook. Illustrated. New York: Spon & Chamberlain. [Cloth. 12mo. 16-304 p. $2.50.]

Houston, Edwin James.=Electricity One Hundred Years Ago and To-day Illustrated. New York: W. J. Johnston Co. [Cloth. 12mo. 199 p. $1.]

Huxley, Thomas H.=Discourses Biological and Geological; Essays. ("Collected Essays," Vol. VIII.) New York: D. Appleton & Co. [Cloth. 12mo. 12-388 p. $1.25.]

Jacob, Ernest H.=Notes on the Ventilation and Warming of Houses, Churches, Schools, and Other Buildings. Illustrated. New York: E. & J. B. Young & Co. [Cloth. 16mo. 123 p. 30 cents.]

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

E. W. Bliss Co., Brooklyn, N. Y., U. S. A. =Catalogue of Flexible Friction Clutch Pulleys. [Describes and illustrates very fully the construction of these pulleys, with sizes and other general information.]

Harrisburg Foundry and Machine Works, Harrisburg, Pa., U. S. A.=The Harrisburg Double Engine Steam Road Roller, Patented. 19 large quarto pages. [Illustrations of various sizes of these machines and description of their details, including special rollers.]

Harrison Brothers & Co., Philadelphia, New York, Cincinnati, U. S. A.=Catalogue and Price List White Lead, Colors, Chemicals, etc. 92 p. [Handsomely illustrated, with much interesting matter relative to the mixture and use of paints, and a brief history of the house of Harrison Brothers & Co.]

Harrisburg Foundry and Machine Works, Harrisburg, Pa., U. S. A.=Portfolio of elegant illustrations of Automatic Engines and leaflet of the same.

Fairbanks, Morse & Co., Kansas City, Mo., U. S. A.=Pumping Machinery for Irrigation, ptepared from address by Ira C. Hubbell, of Kansas City, Mo., before Interstate Irrigation Association, Omaha Convention, March 21 and 22, 1894, etc. [A leaflet of 24 p.]

F. E. Reed Co., Brewster, Mass., U. S. A.= Special Wood Turning Lathe. 12 p. [Designed expressly for use in Manual Training schools.]

The Phosphor Bronze Smelting Co., Limited, Philadelphia, Pa., U. S. A.=Price List. 20 p., exclusive of cover.

Northwestern Expanded Metal Co., Chicago, Ill., U. S. A.=An Argument for Improved House Construction. 16 p., exclusive of cover. [Directions for applying and plastering expanded metal steel lath.]

Johnson Electric Service Co., Boston, Milwaukee, Minneapolis, Detroit, Pittsburg, U. S. A.=The Johnson System of Temperature Regulation. 40 p. [Illustrations of instruments and appliances with descriptive text and list of public buildings in which these appliances are used.]

Street Railway Publishing Co., New York, U. S. A.=Practical Notes on Rope Driving, by M. E. 48 p. [Reprinted from the Street Railway Journal.]

Harrison Brothers & Co., Philadelphia, Pa., U. S. A.=The Chemistry of Paints, and a partial Description of the Harrison White Lead Color and Chemical Works, with a Practical Treatise on Painting. 43 p. [Illustrated with tinted plates and portrait of John Harrison, founder of the house of Harrison Brothers & Co.]

Detroit Dry Dock Co., Detroit, Mich., U. S. A.=Howden Hot Draft System. 16 p. leaflet. [Describing and illustrating the system.]